REPORT RESUMES

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SELF-SELECTED MATHEMATICS LEARNING ACTIVITIES.

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THE PROJECT ATTEMPTED TO PROVIDE A WIDE VARIETY OF MATHEMATICS LEARNING MATERIALS AND TO TEST THE SELF-SELECTION PRINCIPLE IN INVESTIGATING WHAT HAPPENS WHEN SEVENTH- AND EIGHTH-GRADE CHILDREN ARE ASSIGNED THE TASKS OF DETERMINING THEIR OWN MATHEMATICS CURRICULUM ON AN INDIVIDUAL SELF-SELECTION BASIS. THE EXPERIMENTAL GROUP CONSISTED OF 99 STUDENTS. THE CONTROL GROUP CONSISTED OF 172 STUDENTS FROM ANOTHER PUBLIC SCHOOL. PRE- AND POST-TESTS WERE ADMINISTERED TO GATHER DATA ON AGE, ACHIEVEMENT, AND ATTITUDES. OTHER INSTRUMENTS WERE USED TO COLLECT DATA FOR INTRA-EXPERIMENTAL CLASS COMPARISONS AND OBSERVATIONS. THE DATA WERE ANALYZED BY COMPARATIVE ANALYSIS AND INTERCORRELATIONS. THE PROJECT DEMONSTRATED THAT FOR ALL EXCEPT THE BRIGHT STUDENTS (115 IQ AND ABOVE), A TOTALLY INDIVIDUALIZED SELF-SELECTION PROGRAM IS JUST AS EFFECTIVE AS A GOOD CONVENTIONAL PROGRAM. YET THE PROGRAM FAILED TO MEET THE NEEDS OF THE BRIGHTEST STUDENTS IN THE SEVENTH AND EIGHTH GRADES, AS WAYS WERE NOT FOUND IN THIS PROGRAM TO CHALLENGE THE BRIGHT CHILDREN TO LEARN TO THEIR CAPACITY AND TO HAVE POSITIVE FEELINGS ABOUT IT. (TC)

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Cooperative Research Project No. 2047

William M. Fitzgerald

The University of Michigan

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U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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William M. Fitzgerald

The University of Michigan

Ann Arbor, Michigan

1965

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FOREWORD

The opportunity to initiate and complete this project has been an exciting, frustrating and profitable experience for all who contributed to it. Only through the effort and enthusiasm of the entire team was it possible.

Among the numerous people who contributed to the project we must recognize the special work of Professor Joseph Payne, Project Director; Teachers Henry Snyder, eighth grade, Hannelore Wass, fifth grade, and Jerome Gaa, pilot project seventh grade; Bob Goosey, Research Assistant and Observer; William Ebeid, whose doctoral study provided the basis for this study; John McConnell and Nina Satz, Research Assistants; and Gail Haver, Secretary.

The excellent cooperation of the Ann Arbor Public Schools and particularly Alice Hach and Lucille Houston is appreciated and recognized to be essential to successful research.

This project represents the most extensive test thus far of the use of the concept of self-selection in the teaching of mathematics. It is in some sense a pioneering study, yet it represents another link in a very logical search for a more appropriate mathematics curriculum to meet better the needs of individual children. The specific contribution of this study cannot quickly be assessed but the direction in which we are moving is unquestionable and irreversible.

It is personally very gratifying to observe and to be able to participate in these efforts.

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I. THE PROBLEM

Awareness of the differences in children has grown as a product of child development research over the past half century. The extent to which children differ in their capacity to learn mathematics has been shown to be greater than are the usual provisions in the schools to meet those differences.[1] While the range in ability and achievement in any classroom can be expected to be approximately two-thirds of the chronological age, the predominant practice in schools today is to use a single text for a class and expect all children in the class to learn the same idea in the same sequence and at the same time

If it is assumed that a single text cannot be adequate for an entire class, at least three questions arise immediately: 1) What other materials are available and appropriate for children to study? 2) How can the teacher best function in such a classroom? 3) How can a teacher evaluate the children's learning in such a classroom?

There is a growing amount of evidence of attempts to modify the single text approach to mathematics teaching. Several studies have tested the effectiveness of using supplementary enrichment materials in the class as extra work for bright students.[2] Other studies have used programmed materials to allow unique pacing as children learn common materials.

Although these attempts have contributed to improvement in practice, there are still not adequate provisions for unique children to develop unique cognitive mathematical structures in unique sequences to serve unique needs and interests.

The ideal situation in a classroom would exist if every child were actively pursuing a mathematical idea which is intrinsically interesting to him and appropriate for him in terms of his ability and need. Because of the uniqueness of children, a teacher could not be expected to be able to teach these appropriate ideas to all the children in the class. Nor could the teacher select the appropriate material for each child from day to day and week to week. There is some evidence that the person who can best make a decision about what ideas should be studied and when they should be studied is the child himself. This project has attempted to test this idea by examining the following question: "What happens when seventh and eighth grade children are assigned the task of determining their own mathematics curriculum on an individual self-selection basis?" The experiment was carried out with all of the seventh and eighth grade children in The University of Michigan laboratory school during the 1963-64 school year.

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[1] Fitzgerald, William Morley. "A Study of the Factors Related to the Learning of Mathematics by Children in Grades Five, Seven, and Nine." (Unpublished Doctoral Dissertation, University of Michigan, 1962) Dissertation Abstracts, XX111, No. 2, p. 552.

[2] Payne, Joseph Neal. "Enrichment Topics for First and Second Course Algebra for Bright Pupils." (Unpublished Doctoral Dissertation, University of Virginia, 1955) Dissertation Abstracts, XV, No. 3, p. 2491.

The problem was studied from two separate aspects. First, how do children in the experimental setting compare with children who are in a more conventional mathematics program with respect to mathematics achievement, attitude toward mathematics and dependence proneness? Second, in such an experimental class, how do students behave? How does the teacher perform his task? What kinds of students behave in what kinds of ways? What kinds of materials seem to be most appropriate to what kinds of students?

II. OBJECTIVES

The specific objectives of this study with respect to the experimental classes were: 1) To observe systematically the learning activities of individuals in an experimental class subjected to self-selection as a method of classroom learning in seventh and eighth grade mathematics; 2) to continue to develop new learning materials and adapt existing commercial materials so that they will be appropriate for independent study by junior high school students; 3) to measure the frequency and duration of the use of the materials by the students and to determine which kinds of materials provide the most intrinsic appeal for junior high school students.

The specific objective with respect to both the experimental and control classes was: 4) To compare the relative effectiveness of learning mathematics in self-selection classes to learning mathematics in conventional classes in Ann Arbor Public Schools with respect to mathematics achievement, attitude toward mathematics, and dependence proneness as measured by standardized tests.

III. RELATED RESEARCH

The principal stimulus for this project arises out of the growing awareness of the nature of individual differences in children. These differences have been discovered as a result of extensive research in child development which began more than 60 years ago. In summarizing a careful study of child development research Ebeid lists the following theses to furnish a psychological background for the project:

1) Individual differences exist in all aspects of human functions and structures;

2) Individual differences exist at any chronological age and at any of the recognized growth periods;

3) Growth is continuous in all traits, and the approach to maturity is gradual;

4) There is an orderly sequence of growth and development from conception on. But equally significan is that each child, with his unique heredity, his individual maturation and nurture, and life experience, will grow at his own rate of progress, attaining the size, shape, functional capacities, and abilities that are uniquely his own;

5) Each child has a unique pattern of growth, but that pattern is a variant of a basic ground plan;

6) There are differences in the traits within the same individual, hence a child has many ages at a certain time;

7) The various special abilities correlate differentially with each other and with any measure of general ability that is presently used;

8) Differences are not static. Children vary when they enter school, and they develop at different rates.

Consequently, diagnosis must be a continuous process:

9) Differences not accounted for by mental age measures are as important in learning as intellectual ones;

10) There is a possibility of optimum development for all within the frame of growth;

11) All persons are able to make gain in the direction of desirable personal and social goals even though all may not attain the same eventual level;

12) The idea of standards applicable to populations in general has given way to the evidence that the individual child is his own standard;

13) The uniqueness of the individual and the existence of individual differences does not deny that there are essential tendencies which should serve, but as a general guide, and as an approximate indication in approaching problems of certain age. Meanwhile, deviation from norms is "normal";

14) It is difficult to change growth patterns in a substantial fashion by conscious environmental manipulation;

15) Much of human behavior is a function, not of his own physical-mental structure per se, but of the environmental supports, outlets, expectations, and reactions relative to that structure;

16) The early environment of children can be enriched by more intellectual stimulation;

17) The child can be intrinsically motivated through curiosity, stimulation-seeking, exploration, challenge, self-evaluation and feedback aspects of rewards;

18) The healthy child seeks from his environment those experiences that are consistent with his maturity and his needs. We can trust this seeking behavior to tell us much about the readiness of a child for an experience.[3]

Ebeid summarizes the extent and effect of attempts to provide for individual differences in the teaching of mathematics with these generalizations:

1) There is no agreement on their effectiveness.

2) They are mostly oriented toward limited roles of education, namely the search for raising the achievement of certain groups of students. Thus, in such studies almost no attempts have been done to investigate the educational process itself - rather than or beside its end product - in which the students get involved under any approach.

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[3] Ebeid, William Tawadros. "An Experimental Study of the Scheduled Classroom Use of Student Self-Selected Materials in Teaching Junior High School Mathematics," (Unpublished Doctoral Dissertation, University of Michigan, 1964) pp. 23-5.

3) Under most of the provisions, instruction is predominantly group instruction with the same text book and the same sequence for all the students and for all of the time.

4) Other devices which appear more individualized such as enrichment, remedial work and acceleration, are privileges given only to exceptional students, depriving the so-called average pupils.

5) There is an indication that enrichment materials can serve as motivating factors and that enrichment as a device can be applied to students of all abilities.[4]

The use of self-selection as a method for teaching mathematics to children is a relatively untried idea. The kernal of the idea is stated by Rogers: "If we trust the capacity of the human individual for developing his own potentiality, then we can permit him the opportunity to choose his own way in his learning."[5]

The concept of self-selection arose not only in education but also in medicine and is illustrated by the self-selection of diet experiment performed by Clara Davis.[6] There have been several examples of the use of self-selection as a technique of teaching reading.[7] The results of these studies seem to indicate that children learn to read at least as well when in a self-selection process and that there may be more favorable attitudes and reading habits established as a by-product. Two early attempts to use self-selection as a method of teaching mathematics are reported by Ault and Williams.[8,9] Ault's study took place in the third and fourth grade of the University School, University of Michigan in 1943 and 1944. In this minor study the results relating to arithmetic achievement are favorable toward the experiment. In William's study the experimental subjects were a group of thirteen extremely troublesome juveniles who were placed in a self-directed classroom for one semester. Arithmetic achievement in the experimental group was much greater than one would predict on a random basis.

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[4] Ibid. pp. 62-3.

[5] Carl R. Rogers, "Learning to Be Free," NEA Journal (March, 1963) pp. 8-30.

[6] Clara M. Davis, "The Self-Selection of Diet Experiment: Its Significance for Feeding in the Home," Ohio State Medical Journal XXIV (August, 1938), pp. 862-868.

[7] For an excellent review see Ebeid, loc. cit. pp. 64-69.

[8] Bernice Ault, "The Use of Self-Selection Principle in Teaching Arithmetic," (Unpublished Master's Thesis, University of Michigan, School of Education, 1945).

[9] Herbert D. Williams, "An Experiment in Self-Directed Education," School and Society, 31 (May 24, 1930) pp. 715-18.

In commenting upon the use of self-selection as a teaching technique Wallen and Travers say, "Research with this technique is virtually non-existent.[10] In as much as this technique assumes that arousal of motivation and reinforcement will occur without any specific planning by the teacher and that the student will adequately assess his readiness-assumptions which many phychologists would not be willing to grant-further research is imperative."

Of course the recent publication of the book, Summerhill by A. S. Niel, though not a research report, provides a persuasive argument for the effectiveness of self-selection techniques.

Ebeid's study reports the pilot project in the experimental classes at The University of Michigan laboratory school during the 1962-63 school year. This project appears to be the first extensive attempt to use self-selection as a method for learning mathematics at the junior high school level in a carefully controlled situation. The self-selection program was used only approximately 30% of the time. The remainder of the class time was spent in a conventional group-oriented class. The self-selection periods occurred approximately one day each week during the first semester and two days each week during the second semester. The remaining class periods were devoted to the study of SMSG textbooks. The control group was composed of seventh and eighth students in Tappan Junior High School, Ann Arbor, Michigan, who were also studying the SMSG testbooks but with no self-selection activity periods. Ebeid's findings are as follows:

1) There were no significant differences (at the .05 level) between the experimental students and the control students in their mathematics achievement as measured by both the STEP and SMSG tests.

2) There were no significant differences between the two groups in their attitudes toward mathematics.

3) The self-selection periods produced a highly individualized situation where students became, individually, involved in many different activities, most of which were beyond and of a different nature than the concepts and skills covered in the STEP and SMSG tests mentioned before.

4) Although the use of text books was allowed during the self-selection periods, only 22% of the seventh graders time and 9% of the eighth graders time was spent on text book activities.

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[10] Norman E. Wallen and Robert M. W. Travers, "Analysis and Investigation of Teaching Methods," Handbook of Research On Teaching, Rand McNally and Co., Chicago, 1963, pp. 498-9.

5) According to the teachers daily ratings of their students' self-selection ability, the students average corresponded to an "above-medium" level of this ability with seventh graders being ahead of eighth graders on the scale.

6) Although the students recognized that this "self-selection approach" increased their knowledge in and about mathematics, yet they stressed more the psychological contributions. They frequently expressed an appreciation of the opportunity to work independently, each at his own level of interest, rate and ability.

7) The majority of students and teachers showed satisfaction with the approach as a whole and recommended more refinement in the self-selection materials. Ebeid concluded:

> "The students taught with this self-selection approach received some training in working independently, increasing ideas of their own interests, each at his unique level. They became acquainted with many areas in the field of mathematics, and they achieved as well in the 'essentials' as those who were taught through the conventional method. If this can prove anything, it gives a scientific evidence that it is possible to modify the high school mathematics program to a more flexible one where the students, of different levels of ability, as individuals can have a chance to self-select from more of an intellectually stimulating range of mathematical materials to restore the balance between their groups' norms and their unique standards and between the systems' requirements and the individual's own interests.
>
> "The experiment also demonstrated that there is a need for mathematical materials specifically prepared to be used on individual basis."

Some of the results in Ebeid's study, though not statistically significant, do provide a stimulus for further inquiry. Although the attitude test means were not statistically different at the 5% level, all of the control classes had slight decreases in attitude while the experimental classes had slight increases in attitude. This gives rise to the question, would a more concentrated self-selection program produce differences in attitudes?

Several difficulties were encountered during the first year pilot project. First, there was some difficulty in convincing the students that they were actually given the freedom to select the mathematics that they wanted to study. The students must learn that they can work independently and that they are capable of determining what might be valuable for them to study. Throughout the entire year of the pilot project there were some students who continued to be unable to work independently effectively.

Second, although the materials used in the pilot project extended in ability level from second grade to college level, very fiew of the materials were readily adaptable to independent work. Therefore, in order to make the program more effective, additional materials in the form of study guides would have to be developed that would guide the student in the study of a particular idea, that would ask strategic questions and lead him to other sources of material in pursuit of that idea.

Third, many students had trouble adjusting to the alternate dependent and independent class sessions for they could not easily develop or discard interest in a topic. It was evident, however, that the students were very positive in their attitude toward self-selection and continued to request more time to be spent in a self-selection process.

The pilot study provided some positive implications about the effect of self-selection as a method, yet many substantial questions remained unsolved. For this reason a proposal was made to obtain the funds necessary to give a more legitimate test of the idea of self-selection as a method of learning junior high school mathematics.

IV. PROCEDURES

The project described herein took place at the University School, The University of Michigan, during the school year 1963-64 and involved all 50 seventh grade students and 49 eighth grade students in the University School. The experimental variable was the use of self-selection as a method of teaching junior high school mathematics to these children during the entire year.

A. Preparation of the Classroom

During the pilot project in 1962-63 a problem which constantly faced the teachers was how to display the large variety of materials which were available. The experimental classes met in three different rooms on the same floor, so a large metal cart on wheels was purchased, and the materials were displayed on this cart, and the cart was moved from class to class. This difficulty was overcome during the 1963-64 year by having all four of the experimental classes meet in the same room. To provide a display cabinet for the materials, a large cabinet with many small shelf compartments was placed in the room. This provided approximately 200 small spaces for stacks of materials. In addition, an open book shelf, a four-drawer file, and a work bench with storage space below were placed in the room.

At the beginning of the year, seven individual booths from an old language laboratory were installed as individual study space. In addition, some portable four-foot screens were located throughout the room to break up the large space into smaller spaces. Among the study spaces were chairs, tables and desks for 28 children.

In the corners and along the edges of the ceiling were draped strips of burlap in an attempt to reduce the inevitable high noise level which accompanies normal adolescence in old school buildings. As the year progressed, the booths and the screens were eventually eliminated, as it seemed that the class responded better when the teachers could see the students, and the students could see each other. The idea of a small study space is an intriguing one, and it should be explored further. But in the circumstances of this study with extreme space shortages, it was not feasible.

B. Preparation of Materials

The bulk of the expendable materials used to begin the project were experimental materials produced by the SMSG, University of Maryland and Ball State Programs. These materials had been collected over the past few years as the University school had served as a participant in the early SMSG work. These materials were placed in the cabinets by individual chapters and treated as expendable. The remaining materials were either teacher-made or commercially made. All materials were classified by mathematical topic as described in Appendix 1.

All books and pamphlets were numbered and placed on the open shelf. A large amount of varied materials were placed in expandable folders in the four-drawer file along with topic tests and answer sheets.

C. Standardized Testing of Experimental and Control Classes

The control classes for the project consisted of four seventh grade classes and four eighth grade classes in Forsythe Junior High School, Ann Arbor, Michigan. In the Ann Arbor public schools the mathematics program in the seventh and eighth grade operates on a four-track system where the students are grouped by ability. One from each of the tracks in each grade was selected to give 8-control classes.

In the pilot study of the previous year the STEP tests had been used to measure mathematics achievement. Because so many students came so close to the top of the test, it was decided to select an achievement test which would provide a greater chance to measure the high ability students. For this reason it was decided to use the Snader Test of Mathematical Achievement in the experimental and control classes in order to measure the relative achievement of the experimental and control groups.[11] To measure the attitudes of the children the Aiken-Dreger Attitude Scale was used.[12] Dependence proneness was measured by using the Flanders-Amidon Dependence Proneness Scale.[13] The pre-tests were administered to both the experimental and control classes in September, 1963, the post-tests were administered to the classes in mid-May, 1964.

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[11] Snader Test of Mathematical Achievement.

[12] Aiken - Dreger Attitude Scale.

[13] Flanders - Amidon Dependence-Proneness Scale.

In order to compare the metal abilities of the experimental and control students the California Test of Mental Maturity was administered to all experimental and control students in January, 1964.[14]

D. Conducting the Experimental Classes

To be a teacher in a completely individualized class is a unique experience in the life of mathematics teachers who, in general, are not trained to operate in this fashion. The teacher of the seventh grade experimental classes was also the teacher of one of the eighth grade classes in the pilot study of the previous year. He therefore had limited experience in working in an individualized class. The teacher of the eighth grade experimental classes had had no experience in individualized classes before the experiment began. It was, therefore, far from clear at the beginning of the project how a teacher could best behave within the experimental class to perform his role effectively. After considerable discussion about how to begin the first day of the experimental classes both experimental teachers agreed that the best procedure would be to describe a few alternatives which were available to the students in the class and try to get each student working on something rather quickly. As the classes began the students were told briefly the nature of the class procedure for the year, that they would be expected to set their own goals, determine their own mathematical topics for study, and be responsible for their own learning. Two rules were set up within the class by the teacher. These were, first, that the students must spend their time while in mathematics class studying what the teacher would agree to be mathematics. Second, the students must spend their time in such a way as to not interfere with the learning and study of their fellow students.

The teacher's role in the class was then defined to be whatever seemed appropriate in order to enhance the learning of the individual children. This role took on various characteristics, as the experimental classes progressed. The teacher might be working with individual children or with pairs or groups of children and even occasionally talking to the entire class. Frequently the teacher spent time trying to get unruly students to behave in a better fashion. Other times the teacher was trying to help students find material that they could find interesting or trying to help students find materials which were related to some idea that they were pursuing actively.

The systematic analysis and description of the way the students and the teachers spent their time in the experiment classes was done by an observer and is reported in the succeeding chapters and appendices.

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[14] California Test of Mental Maturity.

E. Observing the Students in the Experimental Classes

An observer was hired to observe every experimental class and to gather systematic behavior observation samples on the individual students and the teachers. To observe the students the determination had to be made about what kinds of behavior should be observed. It was decided to observe four specific dimensions of student behavior. These are: 1) gregariousness, 2) industry, 3) activity, and 4) teacher dependency.

The students' gregariousness was measured as one of three states. These states were:

1) alone—meaning the student is not necessarily physically alone, but obviously not interacting with anyone;

2) in a pair—meaning the student is interacting with another person, not necessarily talking, but attentitive to or aware of another person;

3) in a group—meaning the student is interacting with several persons, not necessarily talking but attentive to or aware of other persons.

The students' industry was measured as one of three states. These are:

1) industrious—meaning the student is obviously industrious, giving attention to some activity which can be liberally interpreted as a learning activity; reading, writing, discussion of a problem, examining material, and so forth.

2) Coasting—meaning a lack of attention but yet engaged in a learning activity, also as a doubtful category between industrious and not industrious.

3) Not industrious—meaning either a lack of attention to a learning activity or engaged in behavior obviously not associated with a mathematics learning activity.

The students' activity was measured as one of three states. These are:

1) Passive—meaning the student is engaged in an activity which is judged to be less active than reading or writing.

2) Reading or writing,

3) Active—meaning that he is judged to be more active than reading or writing. Some of the activities in this category are standing, moving

about, talking, any behavior which is overtly directed at other people, and so forth.

The students' dependency upon a teacher is judged simply in one of two states: At a given moment of observation are the teacher and the student interacting or are they not.

The observed student behavior was recorded on a daily observed behavior record, as shown in Appendix 2. Each student was observed by the observer five times during each experimental class. With the observed behavior record in hand and the class roster listed in the left hand column the observer would start down the list of class members looking at each of them and instantaneously making decisions about the student's gregariousness, industry, activity and dependency. Each student observation would then be described by a three-digit numeral. All the digits would be either one, two or three. The first digit described the student's gregariousness, the second digit described the student's industry, the third digit described the student's activity. Finally, if the student was interacting with the teacher at the moment of observation, the three-digit numeral was followed by a "T." If the student was not interacting, then no letter followed the three-digit numeral. The five class observations were spaced through the period so that the first observation would occur in the first five minutes of class. The next three would occur one each during the next three fifteen-minute intervals, and the last observation would occur during the last five minutes of class. The students were completely aware of the observer and were told explicitly the kinds of things he would be observing and the kinds of decisions he would be making. They became oblivious to him very quickly and he attempted as much as possible to refrain from interacting with the students in the class. Those associated with the project were extremely gratified by the observer's ability to remain emotionally unattached to the class, which enhanced the prospects for more valid and reliable observations. The reliability of the student observations will be discussed later.

F. Observing the Teacher in the Experimental Classes

Immediately after the observer observed the students during the three middle observations of the class period he focused on the teacher in the experimental class and observed him carefully for three minutes recording his observations on the three-minute teacher behavior sample form, as shown in Appendix 3. The observer classified the teacher's behavior in one of 5 categories: These are:

1) helping individual students,

2) observing the class,

3) admonishing a student,

4) looking for material for a student,

5) various other activities.

In addition to classifying the teacher's behavior the observer also listed the student with whom the teacher was interacting. In this way it was possible to get a sampling of the number of times the individual students required teacher interaction and also a sample of the total amount of time that individual students required teacher interaction.

G. Evaluating the Student's Work in the Experimental Classes

All of the written work of the student was handed in to the teacher upon completion of the work. The teacher then looked over the work, correcting errors that were found and recorded the fact that the student had completed that particular item of material on the Student Material Use Record as shown in Appendix 4. The materials were then returned to the student to be placed in the student's individual binder which contained a collection of his work for the year.

Each student and many parents were given a list of the materials available in the class, as shown in Appendix 1. These materials are classified according to mathematical topics, but no sequence or difficulty level is implied with the exception of some of the book classifications. Books numbered from B41 to B122 are classified by intended grade levels with the tens and hundreds digits indicating the grades. Students were formally evaluated four times during the year. The evaluation forms are shown in Appendix 5.

The first quarter evaluation form made use of the preliminary achievement test data to attempt to give the child a realistic picture of his relative standing in the class. In addition, information was provided for the student about how well he used his time in class by means of the industry ratio. The industry ratio was simply the percentage of times the student was observed to be clearly industrious, in other words rated as 1 in industry by the observer. The teacher then made a subjective judgement about the quantity and the quality of the work of the child in the experimental class in an individual conference with each child. The factors of industry ratio, quantity and quality of work were used to come to an agreement as to what would be an adequate grade. The preliminary achievement tests were not used to influence the grade in any other way than to attempt to determine the adequacy of the level of materials in which the student had been working.

The grade did not reflect the student's achievement in mathematics relative to the achievement of his classmates. It did reflect how well he used his time while in class and also reflected the quantity and the quality of his work relative to the teacher's judgment of the student's potential. In this way some very slow students received very good grades while some very bright students received poor grades.

Mid-way through the year a letter was sent to the parents describing the teachers reactions to the experiment thus far, attempting to give the parent more information about what his child had been doing in the experimental class. This information consisted of a subjective judgment of the teacher about the child's ability to work independently, a graph of the child's industry ratio for the first half of the year, as shown in relationship to the industry ratio of the experimental group as a whole, and finally a summary of the areas in mathematics in which the child had been working. In addition to this the children were given a semester grade.

At the end of the third quarter evaluation was made on the standard evaluation forms provided by the University School, which allows for a grade and the extensive teacher comment about the child. Again the grades were arrived at only after individual teacher-student conferences.

At the end of the year the teacher filled out a final evaluation form as shown in Appendix 5 with each student in an individual conference. This evaluation required an estimate of the number of ten-page units or their equivalent which had been worked and/or read by the student during the year. In addition, it asked the student which mathematical topics and materials that they particularly enjoyed during the year, and finally, it asked the student what they frankly thought of self-selection as a method of teaching junior high school mathematics. The students were then provided with the summary evaluation form showing their relative placement for the second semester in industry ratio, their relative placement for amount of materials completed, and their relative placement of the post achievement tests. In addition to this they were given a grade.

H. The Fifth Grade Experimental Class

At the beginning of the school year the fifth grade teacher of the University School requested to become part of the experiment as she believed that a self-selected mathematics program would be more appropriate than attempting to provide the students with some uniform mathematical experiences. The teacher was somewhat apprehensive about the project because of her feelings of inadequacy in terms of the mathematical content which the children might wish to explore. In addition to this she was already using large amounts of time preparing materials, and it became clear that if she were going to provide a sufficient amount of materials in mathematics, she would have no time to devote to any of the other necessary subjects. At this point the University School Research and Innovation Committee made a grant of $500.00 to pay for a research assistant to spend two hours each morning in the fifth grade classroom. The research assistant who was hired had completed his bachelor's degree in mathematics at The University of Michigan and was currently working on a certification program for teaching in high school and on a Master's degree in educational administration.

The assistant's time during the first semester primarily was devoted to gathering materials and helping the teacher work with the children individually in seeking mathematical ideas. Special cupboards were built to hold the mimeographed and dittoed expendable materials which were produced for the fifth grade class. As a result of this activity in the fifth grade the teachers of the University Elementary School agreed to participate in the development of a mathematics materials depository which consisted of a four-drawer file in the teacher's lounge containing all of the materials that each teacher used in her mathematics classes. Class-size quantities and the ditto carbons are kept in that mathematics materials depository. This idea, if pursued, would allow each teacher in the elementary school to provide within her classroom materials of sufficient range so that all the children could find appropriate and challenging work.

During the second semester, after adequate supply of materials had been gathered, the assistant began making systematic observations of the students in the classes by observing the same dimensions as were being observed in the seventh and eighth grade experimental classes.

V. ANALYSES OF THE DATA

A. Comparisons Between the Experimental and Control Classes

The data which were gathered in both the experimental and control classes consisted of the chronological age, the metal age, pre and post achievement tests, pre and post attitude tests, and pre and post dependence proneness tests. The experimental classes were seventh and eighth grade classes in the University School, The University of Michigan which were operated on a complete self-selection basis. These classes met four periods each week for 55 minutes.

The control classes were eight seventh and eighth classes in Forsythe Junior High School, Ann Arbor, Michigan. These classes used the School Mathematics Study Group text materials and were conducted in conventional fashions. In each grade there were four different ability levels represented by the four classes. The classes met 5 days a week for 45 minutes each day. The means and standard deviations for the data relating to the experimental and control groups are shown in Tables 1 and 2. All comparisons of means and variances were made with the use of analysis of variance. The experimental and control samples were divided into sub-samples by grade, then by grade and sex, and finally by brightness and sex. In this study, a student is defined as a fast student if he has an I.Q. of 115 or above. A student is defined as a slow student if he has an I.Q. of 114 or below. This I.Q. level was chosen because it separated our experimental and control samples into approximately equal groups. It should be recognized, however, that the vast majority of children in junior high schools in America would be designated as slow under these definitions.

1. CHRONOLOGICAL AGE

The only differences observable in regard to chronological age occur in the seventh grade. The experimental seventh grade is significantly older than is the control seventh grade ($P < .05$).

2. MENTAL AGE

When comparing mental age of the students in the experimental and control classes, it was found that the experimental eighth grade was significantly older, mentally, than was the control eighth grade ($P < .05$). When looking at the sub-samples the experimental eighth grade girls were significantly

TABLE 1

MEAN SCORES FOR STANDARDIZED DATA FOR EXPERIMENTAL (E) AND CONTROL (C) SAMPLES

	N	C.A.	M.A.	Snader Pre Test	Snader Post Test	Attitude Pre Test	Attitude Post Test	Dependence Proneness Pre Test	Dependence Proneness Post Test
E 8	49	162.3	188.6*	25.6	26.1	49.0	45.3	26.4	25.8
C 8	94	160.6	180.5	25.2	28.5	51.3	49.5	26.7	25.7
E 7	50	150.8*	174.7	19.5	20.7	47.7	52.8		27.7
C 7	85	148.5	182.2	19.1	25.2**	54.5**	51.5	27.9	27.0
E 7 Boys	25	151.2	168.7	19.0	20.9	46.2	48.9		27.7
C 7 Boys	42	148.8	188.1	20.9	25.6*	57.3**	55.9	26.0	25.2
E 7 Girls	25	150.4	180.7	19.9	20.5	49.5	57.0*		27.6
C 7 Girls	43	148.2	176.3	17.3	24.7*	51.4	47.3	29.8	28.8
E 8 Boys	25	162.7	184.7	24.8	26.8	51.2	49.7	25.0	23.4
C 8 Boys	50	161.0	184.3	26.6	30.6	52.3	52.8	25.7	24.1
E 8 Girls	24	161.8	192.8**	26.4	25.4	46.7	41.1	27.9	28.1
C 8 Girls	44	160.1	176.4	23.6	26.2	50.1	45.9	27.9	27.4
E Fast Boys	24	156.3	196.1	27.2	26.0	52.5	51.0	27.3	25.5
C Fast Boys	54	152.7	202.7	28.7	34.2**	57.4	54.9	26.7	25.4
E Fast Girls	31	154.5	197.2	24.5	24.6	50.7	52.5	27.1	27.5
C Fast Girls	48	151.3	192.9	22.9	29.5**	50.7	48.8	29.6	29.4
E Slow Boys	26	158.5	159.1	17.2	21.0	43.4	45.6	22.8	25.1
C Slow Boys	38	159.0	155.3	15.9	18.6	50.7*	54.6*	24.8	23.7
E Slow Girls	18	159.5	167.1*	20.1	19.8	42.1	40.2	29.0	29.1
C Slow Girls	39	157.8	153.9	16.7	19.7	51.6*	43.5	27.7	26.6

* P < .05

** P < .01

TABLE 2

STANDARD DEVIATIONS FOR STANDARDIZED DATA FOR EXPERIMENTAL AND CONTROL GROUPS

	N	C.A.	M.A.	Snader Pre Test	Snader Post Test	Attitudes Pre Test	Attitudes Post Test	Dependence Proneness Pre Test	Dependence Proneness Post Test
E 8	49	4.7	21.6	6.8	6.1	14.2	14.2	4.3	5.1
C 8	94	4.7	23.2	9.3	10.4	11.6	14.8	5.6	5.6
E 7	50	5.1	23.2	8.3	6.1	17.3	13.8		4.8
C 7	85	5.1	44.8	8.7	9.3	13.7	16.8	5.8	6.4
E 7 Boys	25	6.2	25.1	8.7	7.2	18.0	14.1		4.9
C 7 Boys	42	6.4	57.7	8.2	9.2	12.2	16.1	3.9	5.6
E 7 Girls	25	3.9	21.7	8.0	5.0	16.7	12.4		4.8
C 7 Girls	43	5.0	25.8	8.9	9.5	14.8	16.5	6.7	6.7
E 8 Boys	25	4.2	23.3	8.0	5.9	14.0	11.3	4.1	5.0
C 8 Boys	50	7.0	21.8	9.6	11.0	11.1	14.2	6.1	6.0
E 8 Girls	24	5.2	18.8	5.4	6.2	14.3	15.7	4.2	4.0
C 8 Girls	44	5.1	24.3	8.7	9.4	12.2	14.8	4.7	4.6
E Fast Boys	24	7.9	10.2	7.1	7.5	16.2	13.9	2.2	5.6
C Fast Boys	54	7.6	43.9	7.8	8.1	11.9	15.4	4.4	6.2
E Fast Girls	31	7.4	14.5	7.6	5.9	17.0	15.8	4.2	4.1
C Fast Girls	48	6.8	13.8	8.5	7.2	14.7	14.6	4.9	4.5
E Slow Boys	26	7.5	22.3	7.3	5.9	15.0	10.8	4.2	5.1
C Slow Boys	38	10.0	14.3	5.9	6.2	10.5	13.7	6.3	5.1
E Slow Girls	18	6.3	17.9	7.0	5.5	9.9	12.9	4.1	4.2
C Slow Girls	39	7.6	18.0	9.0	8.6	11.6	16.1	6.8	6.9

older, mentally, than were the control eighth grade girls. ($P < .01$) In another sub-sample the slow girls in the experimental class were significantly older mentally than were the slow girls in the control class, ($P < .05$).

The eighth grade experimental and control samples were not significantly different in chronological age, but the experimental eighth grade was significantly older mentally than was the control eighth grade. When the mean I.Q. was computed by dividing mean mental age by mean chronological age, the experimental eighth grade has a mean I.Q. of 116 while the control eighth grade has a mean I.Q. of 112.

The experimental seventh grade class was significantly older, chronologically, than was the control seventh grade class, but there was no significant difference in their mental age. When the mean I.Q.'s are computed, the experimental seventh grade has a mean I.Q. of 116 while the control seventh grade has a mean I.Q. of 122. Therefore, the experimental eighth grade class tended to be slightly brighter than was the control eighth grade, while the experimental seventh grade class tended to be slightly slower than was the control seventh grade.

3. MATHEMATICS ACHIEVEMENT

When comparing the experimental and control classes in terms of the mathematics achievement pre-test, there are no differences between any of the sub-samples. When comparing the sub-samples in terms of the post-mathematics achievement test, we find the control seventh grade class significantly higher than the experimental seventh grade class ($P < .01$). In addition, when looking at sub-samples we find both the control seventh grade boys and the control seventh grade girls significantly higher than were their counterparts in the experimental class, ($P < .05$). When classifying for brightness, we find both the fast boys in the control class and the fast girls in the control class significantly higher than were their counterparts in the experimental class. ($P < .005$). In summary then, the control seventh grade class performs sufficiently higher in mathematics achievement than did the experimental seventh grade class, whereas there was no significant difference in performance of the eighth grade control and experimental classes. Fast students, as a group, performed significantly better in the control classes than they did in the experimental classes. Students with I. Q. of 114 and below performed equally well in both groups.

4. ATTITUDE TOWARD MATHEMATICS

There were several differences in attitudes between some of the samples as measured by the attitude tests at the beginning of the year. All of these differences were in favor of the control samples. The seventh grade control group was significantly higher in attitude than was the seventh grade experimental group. ($P < .01$). The seventh grade boys in the control group were significantly higher in attitude than were the seventh grade boys in the experimental group, ($P < .01$). The slow boys in the control group were significantly higher than the slow boys in the experimental group ($P < .05$). The slow girls in the control group were significantly higher than the slow girls in the experimental group, ($P < .05$).

In the attitude tests administered at the end of the year some of the differences observed at the beginning of the year had vanished, and some new differences had appeared. The superiority of the control seventh grade over the experimental seventh grade vanished. The superiority of the control seventh grade boys over the experimental seventh grade boys vanished. The experimental seventh grade girls were now significantly higher than were the control seventh grade girls ($P < .05$). The control slow boys continued to be significantly higher than the experimental slow boys, ($P < .05$). The difference between the control slow girls and the experimental slow girls vanished.

The pre and post attitude tests allow the conclusion that any changes occurring in attitude in the samples throughout the year were always in favor of the experimental samples. Relative changes in attitude occurred in favor of the experimental seventh grade, the experimental seventh grade boys, the experimental seventh grade girls, and the experimental slow girls. It is interesting to note that three of the four samples which had a superior gain in attitude also had a relatively inferior gain in achievement.

5. DEPENDENCE PRONENESS

There were no significant differences in either the pretest or posttest of the dependence proneness scale for any of the samples.

6. DIFFERENCES IN VARIABILITY

The following experimental samples were found to be significantly more variable than their matched control samples: The slow boys on the mental ability test and the seventh grade, the eighth grade, the seventh grade boys, the fast boys, and the slow boys on the attitude pre-test. In no case was a control case more variable than on experimental sample.

B. Analysis of the Intra-Experimental Class Data

The following kinds of data were gathered for the experimental sample:

1) growth measurements,

2) standardized achievement tests,

3) standardized affective tests,

4) observed student behavior,

5) observed student-teacher interaction,

6) student work output,

7) teacher judgment of student self-selection competency.

These data are analyzed in two phases. In Phase One the experimental samples are separated according to brightness, grade, and sex. The means and the variability of the samples are then compared. In Phase Two the interrelationships between the various kinds of data are examined by using intercorrelations.

1. PHASE ONE

A. Growth Measurements

The only variable which will be considered under growth measurements in Phase One is chronological age as shown in Table 3.

TABLE 3

MEANS AND STANDARD DEVIATIONS OF CHRONOLOGICAL AGE FOR EXPERIMENTAL SAMPLES

	N	Mean C.A.	Standard Deviation
E Fast Boys	24	156.3	7.9
E Slow Boys	26	158.5	7.5
E Fast Girls	31	154.5	7.4
E Slow Girls	18	159.5	6.3
E 7 Boys	25	151.2	6.2
E 8 Boys	25	162.7	4.2
E 7 Girls	25	150.4	3.9
E 8 Girls	24	161.8	5.2

(1) Brightness Comparisons. In the experimental groups the slow girls were found to be significantly older than the fast girls, ($P < .05$).

(2) Grade Comparisons. As would be expected, all of the eighth grade samples in both the experimental and control groups were significantly older than the corresponding seventh grade samples, ($P < .01$).

(3) Sex comparisons. There were no significant differences in the mean chronological ages between the boys and girls in any of the samples in either the experimental or control classes.

B. Standardized Achievement Test Data

In Phase One standardized achievement data include mental age, Snader Mathematics Achievement Pre and Post Tests, the Sequential Test of Educational Progress-Mathematics,[15] and the Evans mathematics creativity test[16] as shown in Table 4.

(1) Brightness Comparisons. As one might expect, both the fast boys and the fast girls were significantly older mentally as measured by the California Mental Maturity Test than were the slow boys and the slow girls, ($P < .01$).

In the Snader Mathematics Achievements Test at the beginning of the year the fast boys scored significantly higher than did the slow boys, ($P < .01$). There were no differences between the scores of the fast and slow girls.

In the post-Snader Mathematics Achievement Test both the fast boys and the fast girls scored significantly higher than did the slow boys and the slow girls, ($P < .05$).

On the STEP test administered at the end of the year both the fast boys and the fast girls scored significantly higher than did the slow boys and the slow girls, ($P < .01$).

On the Evans Mathematical Creativity Test, administered late in the first semester, both the fast boys and the girls scored significantly higher than did the slow boys and the slow girls, ($P < .01$).

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[15] Sequential Test of Education Progress - Mathematics Cooperative Test Division, Educational Testing Service, Princeton, New Jersey.

[16] Evans Test of Mathematical Creativity, Edward William Evans. Measuring the Ability of Students to Respond in Creative Mathematical Situations. Unpublished doctoral dissertation, University of Michigan, 1964.

TABLE 4

MEANS AND STANDARD DEVIATIONS OF STANDARDIZED ACHIEVEMENT DATA FOR THE EXPERIMENTAL SAMPLES

		Mental Age		Snader-Pre		Snader-Post		Step Test		Evans Test	
Sample	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
E Fast Boys	24	196.1	10.2	27.2	7.1	26.0	7.5	35.0	5.8	512.0	43.9
E Slow Boys	26	159.1	22.3	17.2	7.3	21.0	5.9	24.5	7.4	434.3	57.2
E Fast Girls	31	197.2	14.5	24.5	7.6	24.6	5.9	34.1	8.4	545.6	54.4
E Slow Girls	18	167.1	17.9	20.4	7.0	19.8	5.5	25.9	6.5	491.2	62.1
E 7 Boys	25	168.7	25.1	19.0	8.7	20.9	7.2	29.5	8.3	477.3	57.2
E 7 Girls	25	180.7	21.7	19.9	8.0	20.5	5.0	30.1	9.4	524.4	73.1
E 8 Boys	25	184.7	23.3	24.8	8.0	26.8	5.9	30.3	8.7	464.6	70.8
E 8 Girls	24	192.8	18.8	26.4	5.4	25.4	6.2	32.5	8.0	536.5	46.6

(2) Grade Comparisons. Both the eighth grade boys and the eighth grade girls were significantly older, mentally, than were the seventh grade boys and the seventh grade girls, ($P < .05$).

In the Snader Pre-Test both the eighth grade boys and the eighth grade girls scored significantly higher than did their seventh grade counterparts, ($P < .05$). In the Snader Post-Test the eighth grade samples again scored significantly higher than did the seventh grade samples, ($P < .01$).

There were no significant differences in the means between the seventh and eighth grade samples on either the STEP test or the Evans Mathematical Creativity Test.

(3) Sex Comparisons. There were no significant differences in the means between boys and girls in the mental age measures.

In the Snader Pre- and Post-Tests there were no significant differences in the mean scores between boys and girls.

There were no significant differences in either the means between boys and girls on the STEP test.

On the Evans Mathematical Creativity Test the girls' sample means were always significantly higher than were the corresponding boys' sample means. Seventh grade girls were higher than seventh grade boys, ($P < .05$). Eighth grade girls were higher than eighth grade boys, ($P < .01$). The fast girls were higher than the fast boys, ($P < .05$). Slow girls were higher than slow boys, ($P < .05$).

C. Standardized Affective Test Data

The standardized effective test data includes pre and post scores on the attitude scale and pre and post scores on the dependence-proneness scale as shown in Table 5.

(1) Brightness comparisons. There were no significant differences in the mean scores on the attitude pre test between the bright and slow samples.

On the attitude post tests the fast girls scored significantly higher than did the slow girls, ($P < .05$).

On the dependence-proneness pre-test the fast boys scored significantly higher, meaning they would be more independent than were the slow boys, ($P < .01$). There were no significant differences between any of the samples in the post-test when compared by brightness.

TABLE 5

MEANS AND STANDARD DEVIATIONS OF STANDARDIZED AFFECTIVE TESTS FOR THE EXPERIMENTAL SAMPLES

Sample	N	Attitude-Pre		Attitude-Post		Dependence-Proneness-Pre		Dependence-Proneness-Post	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
E Fast Boys	24	52.5	16.2	51.0	13.9	27.3	2.2	25.5	5.6
E Slow Boys	26	43.4	15.0	45.6	10.8	22.8	4.2	25.1	5.1
E Fast Girls	31	50.7	17.0	52.5	15.8	27.1	4.2	27.5	4.1
E Slow Girls	18	42.1	9.9	40.2	12.9	29.0	4.1	29.1	4.2
E 7 Boys	25	46.2	18.0	48.9	14.1			27.7	4.9
E 7 Girls	25	49.5	16.7	57.0	12.4			27.6	4.8
E 8 Boys	25	51.2	14.0	49.7	11.3	25.0	4.1	23.4	5.0
E 8 Girls	24	46.7	14.3	41.1	15.7	27.9	4.2	28.1	4.0

(2) Grade Comparisons. There were no significant differences in the means between any of the samples on the attitude pre-test when compared by grade. In the post-attitude test the seventh grade girls scored significantly higher than did the eighth grade girls, ($P < .01$).

There were no significant differences in either the means in the dependence-proneness pre-test when the samples were compared by grades.

The seventh grade boys scored significantly higher than the eighth grade boys on the dependence-proneness post-test, ($P < .01$).

(3) Sex Comparisons. There were no significant differences in the means between the samples when compared by sex on the attitude pre-test.

On the attitude post-test the seventh grade girls scored significantly higher than did the seventh grade boys, ($P < .05$). However, the eighth grade boys scored significantly higher than did the eighth grade girls, ($P < .05$).

On the dependence-proneness pre-test the eighth grade girls scored significantly higher than the eighth grade boys, ($P < .05$).

In the dependence-proneness post-test, again the eighth grade girls scored significantly higher than the eighth grade boys, ($P < .01$). In addition the slow girls scored significantly higher than did the slow boys, ($P < .01$).

D. Observed Student Behavior Data

In Chapter III a description of the observer's techniques and criteria for observation were presented in which samples of the students' behavior was classified according to gregariousness, industry, and activity. When the observer made his observations he classified each of these three dimensions into three possible categories. This allowed each sample of student behavior to be classified into one of 27 cells in a three by three by three cube. In order to make these observations more managable each of the three dimensions were re-classified into two instead of three categories. In the industry dimension, instead of classifying the child as obviously industrious, coasting, and obviously not industrious, the behavior samples were classified only as obviously industrious or not obviously industrious. In the aloneness dimension all the samples were classified as either alone or not alone, pooling the samples in which the children were observed to be in a pair with those in which the children were observed to be in a group. In the activity category the samples were classified as either more active than reading and writing or not more active than reading and writing, pooling the samples in which the child was observed to be reading and writing with those in which he was observed to be more passive than reading and writing. The new classifications allow each of the three dimensions to be classified into two ways allowing the data to be placed into one of eight cells in a two by two by two cube.

The new classifications are as follows:

Area 1 - Alone, Industrious, Active
Area 2 - Alone, Unindustrious, Active
Area 3 - Alone, Industrious, Passive
Area 4 - Alone, Unindustrious, Passive
Area 5 - Group, Industrious, Active
Area 6 - Group, Unindustrious, Active
Area 7 - Group, Industrious, Passive
Area 8 - Group, Unindustrious, Passive.

In Phase One the means and standard deviations of the precent of time spent in each of the eight behavioral areas are presented for the first semester and for the second semester for each of the sub-samples. In addition, the means and standard deviations of the percent of time the children were observed to be industrious, the percent of time they were observed to be alone, and the percent of time they were observed to be active are presented for both the first and the second semester.

Table 6 shows the means and standard deviations of the percent of time the students were observed to be in the first four behavioral areas-those in which they were alone.

(1) Brightness Comparisons. When comparing the means of the percent of time the fast samples spent in Area 1 to the percent of time the slow students spent in the Area 1, there were no significant differences during either the first or the second semester.

The slow boys spent significantly more time in the Area 2 than did the fast boys, ($P < .05$). This difference vanished during the second semester.

During the first semester there were no significant differences in the percent of time that the samples spent in Area 3.

During the second semester the fast girls spent significantly more time in Area 3 than did the slow girls, ($P < .01$).

The slow boys spent significantly more time during the first semester in Area 4 than did the fast boys, ($P < .05$). This difference vanished during the second semester.

Table 7 contains the means and standard deviations of the percent of time the students were observed to be in each of the four categories involved with group behavior. The fast boys spent significantly more time in Area 5 during the first semester than did the slow boys, ($P < .05$).

The slow girls were found to spend more time in Area 6 during the second semester than did the fast girls, ($P < .05$).

TABLE 6

MEANS AND STANDARD DEVIATIONS OF OBSERVED STUDENT BEHAVIOR PERCENT OF TIME SPENT IN ALONE CATEGORIES

		Area 1 Industrious-Active				Area 2 Unindustrious-Active			
Sample		1st Sem.		2nd Sem.		1st Sem.		2nd Sem.	
	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
F B	24	8.7	7.9	5.0	4.7	10.4	5.6	7.7	4.1
S B	26	7.2	5.1	5.9	4.1	14.5	7.2	9.5	5.5
F G	31	5.9	5.3	5.5	3.0	9.2	3.9	5.0	2.8
S G	18	5.8	4.2	5.8	4.5	9.2	5.5	6.1	3.5
7 B	25	11.3	7.0	7.2	5.0	14.8	7.4	9.9	5.6
7 G	25	8.4	5.5	6.5	3.8	11.8	3.7	6.6	3.3
8 B	25	4.1	3.0	3.6	2.6	10.0	4.8	7.3	3.5
8 G	24	3.2	2.2	4.8	3.0	6.7	3.5	4.2	2.3

		Area 3 Industrious-Passive				Area 4 Unindustrious-Passive			
		1st Sem.		2nd Sem.		1st Sem.		2nd Sem.	
	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
7 B	25	32.0	15.4	30.9	11.0	7.5	3.7	5.1	5.9
7 G	25	41.6	12.3	42.3	16.2	8.2	3.7	5.3	3.0
8 B	25	28.1	9.5	24.9	11.4	8.5	4.3	7.7	3.3
8 G	24	48.5	16.6	39.6	14.1	8.7	4.6	5.6	3.7
F B	24	31.4	11.5	30.1	9.1	6.8	4.2	5.2	4.3
S B	26	28.9	14.3	25.2	13.1	9.2	3.4	7.6	5.2
F G	31	47.2	15.4	44.7	14.7	8.1	4.6	5.5	3.4
S G	18	40.7	13.1	32.7	12.8	9.2	3.1	5.4	3.4

TABLE 7

MEANS AND STANDARD DEVIATIONS OF OBSERVED STUDENT BEHAVIORS - PERCENT OF TIME SPENT IN GROUP CATEGORIES

		Area 5 Industrious-Active				Area 6 Unindustrious-Active			
		1st Sem.		2nd Sem.		1st Sem.		2nd Sem.	
Sample	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
7 B	25	9.5	6.5	15.6	7.4	17.7	7.1	14.2	5.7
7 G	25	7.0	3.0	12.1	5.8	17.0	7.6	10.5	6.8
8 B	25	6.7	3.8	9.0	4.4	32.0	8.2	25.2	8.6
8 G	24	5.0	4.4	9.9	5.8	18.8	10.0	20.1	9.6
F B	24	10.0	6.5	13.9	7.5	24.9	9.9	19.6	9.3
S B	26	6.4	3.8	11.0	6.1	24.3	11.2	19.4	9.0
F G	31	6.3	3.7	10.2	5.6	16.4	9.2	13.1	8.8
S G	18	5.3	4.1	12.5	6.3	21.1	7.3	20.3	9.7

		Area 7 Industrious-Passive				Area 8 Unindustrious-Passive			
		1st Sem.		2nd Sem.		1st Sem.		2nd Sem.	
Sample	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
7 B	25	2.9	1.8	12.6	5.2	3.6	2.1	4.1	2.1
7 G	25	2.6	1.4	13.1	6.4	3.5	1.5	3.9	2.4
8 B	25	3.1	2.3	8.6	6.4	8.1	2.4	13.6	6.3
8 G	24	2.8	1.4	8.8	3.3	6.7	5.2	7.3	4.8
F B	24	3.4	2.4	9.9	5.5	5.2	3.6	7.7	5.7
S B	26	2.6	1.6	11.4	6.7	6.3	3.0	9.7	7.4
F G	31	2.8	1.4	11.3	6.0	4.5	3.4	5.1	3.9
S G	18	2.5	1.4	10.0	4.2	6.5	5.2	6.9	4.5

When the percent of time that the children spent in Area 7 and Area 8 is compared by brightness we find no significant differences in the means.

Table 8 shows the means and standard deviations for the percent of time that the student were observed to be clearly industrious. These data disregard the other dimensions of the student behavior - activity and gregariousness.

TABLE 8

MEANS AND STANDARD DEVIATIONS OF PERCENT OF OBSERVED INDUSTRIOUS STUDENT BEHAVIOR

		1st Sem.		2nd Sem.	
Sample	N	Mean	S.D.	Mean	S.D.
7 B	25	55.9	13.1	66.3	11.4
7 G	25	59.3	11.0	74.0	11.0
8 B	25	40.9	10.8	46.0	10.8
8 G	24	59.1	15.3	63.0	15.4
F B	24	52.5	12.8	59.6	13.9
S B	26	44.8	14.5	53.5	15.7
F G	31	61.8	12.6	71.7	13.0
S G	18	53.7	13.4	61.3	15.2

In the first semester the fast boys and the fast girls were observed to be industrious a greater percent of time than were the slow boys and the slow girls, ($P < .05$). During the second semester the differences between the fast boys and the slow boys vanished, but the fast girls continued to spend significantly more time industriously than did the slow girls, ($P < .05$).

Table 9 shows the means and standard deviations of the percent of time that the students were observed to be alone. These data ignore the dimensions of industry and activity.

TABLE 9

MEANS AND STANDARD DEVIATIONS OF PERCENT OF OBSERVED STUDENT BEHAVIOR ALONE

Sample	N	1st Sem. Mean	1st Sem. S.D.	2nd Sem. Mean	2nd Sem. S.D.
7 B	25	65.6	11.6	52.4	12.2
7 G	25	70.0	8.7	60.6	14.8
8 B	25	50.4	10.6	43.4	12.8
8 G	24	66.7	15.6	54.1	13.4
F B	24	57.0	13.8	48.0	11.2
S B	26	59.6	13.2	48.2	15.1
F G	31	70.2	13.6	60.1	14.9
S G	18	64.3	9.6	51.3	11.1

During the first semester there were no significant differences in the percent of time that samples of students spent alone when compared by brightness. During the second semester the fast girls were observed to spend significantly more time alone than did the slow girls, ($P < .05$).

Table 10 shows the mans and standard deviations of the percent of time that the students were observed to be active, which means they were observed to be more active than reading and writing. These data ignore the other dimensions of student behavior - gregariousness and industry. During the first semester there were no differences in the percent of time that the students were observed to be active when the samples are compared by brightness. During the second semester the slow girls were observed to be more active than were the fast girls, ($P < .01$).

(2) Grade Comparisons. When comparing the seventh grade samples with the eighth grade samples, both the seventh grade boys and seventh grade girls spent significantly more time in the Area 1 than did the eighth grade boys and eighth grade girls during the first semester, ($P < .01$). During the second semester the seventh grade boys again spent more time in Area 1 than did the eighth grade boys, ($P < .05$), but the differences between the seventh and eighth grade girls vanished.

TABLE 10

MEANS AND STANDARD DEVIATIONS OF PERCENT OF OBSERVED ACTIVE BEHAVIOR

Sample	N	1st Sem. Mean	1st Sem. S.D.	2nd Sem. Mean	2nd Sem. S.D.
7 B	25	53.6	15.2	45.6	11.1
7 G	25	44.1	12.7	36.4	13.5
8 B	25	50.7	9.6	45.1	10.9
8 G	24	33.0	14.2	38.5	10.6
F B	24	53.2	13.3	46.2	11.2
S B	26	51.3	12.8	44.6	10.8
F G	31	37.3	15.2	34.1	11.1
S G	18	40.9	12.8	44.5	11.1

Both the seventh grade boys and seventh grade girls spent more time in Area 2 during the first semester than did the eighth grade boys and eighth grade girls, ($P < .01$). During the second semester the differences between the boys' sample means vanished, but the seventh grade girls continued to spend more time in Area 2 than did the eighth grade girls, ($P < .01$).

There were no significant differences in the amount of time that the students spent in the Area 3 or Area 4 between either the first or second semester when the samples of students are compared by grade.

There were no differences between the amount of time that the different grade samples spent in Area 5 during the first semester, but the seventh grade boys spent significantly more time in Area 5 during the second semester than did the eighth grade boys, ($P < .01$).

The eighth grade boys spent significantly more time in Area 6 during the first semester than did the seventh grade boys, ($P < .01$). During the second semester both the eighth grade boys and eighth grade girls spent more time in Area 6 than did the seventh grade boys and seventh grade girls, ($P < .01$).

In Area 7 there are no differences in the amount of time that the students spent when compared by grade level during the first semester. In the second semester, however, both the seventh grade boys and the seventh grade girls spent significantly more time in Area 7 than did the eighth grade boys and the eighth grade girls, ($P < .01$).

Both the eighth grade boys and eighth grade girls spent more time in Area 8 than did the seventh grade boys and the seventh grade girls during both the first and second semesters, ($P < .01$).

The seventh grade boys were observed to be industrious a greater percent of time than were the eighth grade boys during the first semester, ($P < .01$). During the second semester both the seventh grade boys and the seventh grade girls were observed to be industrious a greater percent of the time than were the eight grade boys and the eighth grade girls, ($P < .01$). When the percent of time that the children were observed to be alone is compared by grade level, the seventh grade boys were found to be alone a greater percent of time than were the eighth grade boys during both semesters, ($P < .01$). There was no difference in the percent of time that the seventh grade and eighth grade girls spent alone.

During the first semester the seventh grade girls were observed to be active a greater percent of time than were the eighth grade girls, ($P < .01$). There was no difference in the percent of time the seventh and eighth grade boys were observed to be active.

During the second semester there were no differences in the percent of time the students were observed to be alone when the samples were compared by grade level.

(3) Sex Comparisons. When comparing the samples by sex for the percent of time that the children spent in behavioral Area 1, there were no significant differences between the boys and girls. These findings were consistent for both semesters' observations. When examining the percent of time children spent in behavior Area 2 during the first semester, both the eighth grade boys and the slow boys spent significantly more time in this area than did the eighth grade girls and the slow girls, ($P < .05$). During the second semester every sample of boys was found to have a larger percentage of time in Area 2 than did the corresponding sample of girls. The seventh grade boys spent more time in Area 2 than did the seventh grade girls, ($P < .05$). The eighth grade boys, the fast boys and the slow boys all spent more time in Area 2 than did the eighth grade girls, the fast girls and the slow girls ($P < .01$).

When examining the percent of time that the children spent in the behavioral Area 3 during the first semester, every sample of girls was found to have a higher percent of time in Area 3 than did the corresponding sample of boys. The seventh grade girls and the slow girls spent more time in Area 3 than did the eighth grade boys and the fast boys, ($P < .01$). During the second semester every sample of girls except the slow girls continued to spend significantly more time in behavioral Area 3. The seventh grade girls, the eight grade girls and the fast girls all spent more time than did the seventh grade boys, the eighth grade boys and the fast boys, ($P < .01$).

There were no differences between the percent of time the samples spent in Area 4 during the first semester when compared by sex. During the second semester, however, the eighth grade boys were found to spend more time in Area 4 than did the eighth grade girls, ($P < .05$).

The fast boys were found to spend more time in Area 5 than did the fast girls during both the first semester, ($P < .01$) and the second semester, ($P < .05$).

The eighth grade boys and the fast boys both spent more time in Area 6 during the first semester than did the eighth grade girls and the fast girls, ($P < .01$).

During the second semester the fast boys continued to spend more time in Area 6 than did the fast girls, ($P < .01$). The difference between the eighth grade boys and girls vanished. However, the seventh grade boys were found to spend more time in Area 6 than did the seventh grade girls, ($P < .05$).

There were no differences in the amount of time the children spent in Area 7 when compared by sex during either semester.

There were no differences in the amount of time the various samples spent in Area 8 during the first semester when compared by sex. During the second semester, however, the eighth grade boys and the fast boys were found to be in Area 8 more than were the eighth grade girls ($P < .01$) and the fast girls ($P < .05$).

The industry ratio indicates the percent of time the child was observed to be clearly industrious. During the first semester the eighth grade girls and the fast girls were both observed to be more industrious than were the eighth grade boys and the fast boys, ($P < .01$). During the second semester the eighth grade girls, the fast girls and also the seventh grade girls were found to be more industrious than were the eighth grade boys and the fast boys ($P < .01$) and the seventh grade boys ($P < .05$).

The aloneness ratio represents the percent of time that the child was observed to be working alone as opposed to being in a pair or in a group. During the first semester only the eighth grade girls were found to be more alone than were the eighth grade boys, ($P < .01$). However, during the second semester the eighth grade girls, the fast girls and the seventh grade girls were all observed to be more alone than were the eighth grade boys and the fast boys ($P < .01$) and the seventh grade boys ($P < .05$).

The activity ratio represents the percent of time the child was observed to be more active than reading and/or writing. During the first semester every sample of boys was found to be more active than the corresponding samples of girls. The seventh grade boys and the slow boys were more active than the seventh grade girls and slow girls, ($P < .05$). And the eighth grade boys and the fast boys were found to be more active than the eighth grade girls and the fast girls ($P < .01$). During the second semester only the slow boys were not found to be more active than their corresponding samples of girls. The seventh grade boys and the eighth grade boys were both more active than were the seventh grade girls and the eighth grade girls ($P < .05$). The fast boys were found to be more active than were the fast girls ($P < .01$).

E. Observed Student-Teacher Interaction

Each time the observer in the classroom observed a sample of student behavior, one of the items of information regarded was whether or not the teacher and student were interacting at that moment. As a result of these observations each student was assigned a number indicating the percent of times he was observed to be interacting with the teacher in comparison to the total number of student-teacher interactions observed throughout the year.

In addition, to the student observations three times during each experimental class period the observer observed the teacher for a three minute period recording the kinds of behavior that the teacher was displaying at ten-second intervals. Any time this behavior involved a student, the student's name was recorded. From these data it is possible to count the number of times each child was observed to be interacting with the teacher during the three-minute teacher observations. It is also possible to count the total amount of time that the teacher and the child spent interacting during the three-minute teacher observations. Both of these kinds of data, the frequency and the total time of student-teacher interaction were, calculated as percents of the total observed frequency and total observed teacher-student interaction time for the entire class for the first semester and for the second semester. These data are shown in Table 11.

(1) Brightness Comparisons. When comparing the experimental samples by sex the slow boys were observed to be interacting with the teacher more often than were the slow girls according to the student observations, ($P < .05$).

This difference did not appear in the three-minute teacher interactions as there were no differences between any of the samples for either semester when compared by sex.

(2) Grade Comparisons. According to the student observations during the entire year the seventh grade girls were observed to be interacting with the teacher more often than were the eighth grade girls, ($P < .05$). However,

TABLE 11

MEANS AND STANDARD DEVIATIONS OF PERCENT OF OBSERVED STUDENT TEACHER INTERACTIONS

		Total from Student-Observation		Number of times from Teacher-Observation				Total time from Teacher-Observations			
				1st Sem.		2nd sem.		1st Sem.		2nd Sem.	
Sample	N	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
7B	25	5.8	3.9	4.4	2.1	4.2	2.0	3.9	2.1	3.1	2.4
7G	25	5.8	2.6	3.7	2.1	3.7	2.8	3.9	2.7	3.1	2.8
8B	25	4.4	2.7	4.4	2.5	3.4	2.3	4.1	2.9	2.9	2.6
8G	24	3.3	2.8	4.5	2.4	4.9	2.6	4.1	1.9	5.5	4.1
FB	24	4.1	2.9	3.9	2.1	3.7	2.2	3.3	1.8	3.1	2.9
SB	26	6.1	3.7	4.9	2.4	4.0	2.1	4.6	2.9	2.9	2.1
FG	31	5.3	3.0	3.9	2.5	4.2	2.7	3.8	2.4	3.9	2.9
SG	18	3.5	2.7	4.4	1.7	4.7	2.8	4.5	2.1	5.2	5.0

from the data obtained in the three-minute teacher observations the eighth grade girls were observed to be interacting with the teacher more of the total time during the second semester than were the seventh grade girls, ($P < .05$). There were no other differences between the samples when compared by grade.

(3) Sex Comparisons. From the data gathered through student observations for the entire year the slow boys were observed to be interacting with the teacher more than were the slow girls, ($P < .05$).

From the three-minute teacher observation data for the first semester there were no differences in the samples when compared by sex. However, during the second semester the eighth grade girls were observed to be interacting with the teacher both more often and for a greater total time than were the eighth grade boys ($P < .05$). In addition, the slow girls were observed to be interacting with the teacher for a greater total time than were the slow boys during the second semester, ($P < .05$).

F. Student Work Output

All of the written material completed by the student was handed in to the teacher. The teacher corrected it, recorded the item of material, the date and handed the material back to the student to be placed in the student's binder. The items of material varied extensively in difficulty and length and in the nature of student response required. At the end of the year, during the student-teacher conference, a counting was made of the number of pages in the student's binder which had been completed by the student. In addition an estimated number of pages read and/or worked in pamphlets and in texts in the room was added. From this total estimate a number of assigned to the student indicating the equivalent of thenumber of ten-page units of work which had been completed by the student throughout the year. Means and standard deviations of these data are found in Table 12.

TABLE 12

MEANS AND STANDARD DEVIATIONS OF NUMBER OF 10-PAGE UNITS COMPLETED BY THE STUDENTS DURING THE YEAR

Sample	N	Mean	S.D.
7 B	25	16.4	15.0
7 G	25	21.6	9.2
8 B	25	14.3	11.7
8 G	24	16.4	12.6
F B	24	18.5	13.5
S B	26	12.4	12.9
F G	31	22.0	11.9
S G	18	17.3	6.1

(1) Brightness Comparisons. When the experimental samples were compared by brightness, there was no difference between the amount of materials completed by the boys samples, but the fast girls were found to have completed significantly more ten-page units during the year than did the slow girls, $(P < .01)$.

(2) Grade Comparisons. When the experimental samples were compared by grade, there were no significant differences in the number of ten-page units completed by the children.

(3) Sex Comparisons. There were no significant differences in the number of ten-page units completed by the students in the experimental samples when compared by sex.

G. Teacher Judgment of Student Self-Selection Performance

At the end of the year both experimental class teachers were asked to rate their students, one, two, or three, depending upon their ability to work in the self-selection atmosphere. A score of one indicates a child who is usually seeking mathematical ideas in the self-selection classroom and was performing in such a way as to contribute to the well being of the class. A rating of three was given to a person who in the teacher's judgment usually did not seek mathematical ideas in the classroom and did not contribute to the well being of the class. A two rating was a person who was neither of the extremes. The means and standard deviations of the teachers' judgments for the various samples are found in Table 13.

TABLE 13

MEANS AND STANDARD DEVIATIONS OF TEACHER JUDGMENT OF STUDENT'S SELF-SELECTION ABILITY

Sample	N	Mean	S.D.
7 B	25	2.1	.8
7 G	25	1.5	.7
8 B	25	2.2	.6
8 G	24	1.7	.7
F B	24	1.9	.7
S B	26	2.3	.7
F G	31	1.6	.7
S G	18	1.6	.7

(1) Brightness Comparisons. There were no differences in the ability of the students to operate in the self-selection situation as judged by the teacher when the samples were compared by brightness.

(2) Grade Comparison. There were no differences in the students' ability to operate in the self-selection situation as judged by the teacher when the samples were compared by grades.

(3) Sex Comparisons. The seventh grade boys and the eighth grade boys and the slow boys were all found to be able to operate less well in a self-selection situation as judged by the teacher than were the seventh grade girls, the eighth grade girls ($P < .05$) and the slow girls, ($P < .01$).

2. PHASE TWO ANALYSIS OF THE INTERRELATIONSHIPS BETWEEN THE VARIOUS KINDS OF VARIABLES

The relationships between the various kinds of variables gathered in this study are examined by means of intercorrelations. Only relationships which are probable at the 95% level or greater will be discussed and are shown in Tables 14-17.

A. Relation of Growth Measurements to Standardized Achievement Test Scores

Two relationships were found in this area, both of which would be predictable and understandable. Children who were older chronologically tended to do better on the Snader Pre-test ($r = .21$). The second relationship found to be probable at the 95% level was the relationship between height age and mental age ($r = .76$). This relationship is consistentwith developmental concept in which the child grows as a total organism.

B. Relationships Between Growth Measurements and Standardized Affective Test Scores

The only significant relationship found between growth data and standardized affective tests was a negative relationship between chronological age and the gain on the attitude test between the beginning and the end of the year ($r = -.31$). This would indicate that the younger children had a more positive reation to the self-selection experience than did the older children.

C. Relationships Between Growth Measurements and Observed Student Behavior

Throughout the analysis of the data it was observed that there was an inverse relationship between the status of the child on any given measurement

TABLE 14

SIGNIFICANT INTERCORRELATIONS BETWEEN GROWTH DATA AND THE OTHER KINDS OF DATA

(n=99, $p < .05$)

	Growth Data			
		Gain		
Standardized Achievement Tests	CA	HA	HA	WA
Mental Age		.76		
Snader Pre Test	.21			
Standardized Affective Test				
Gain in Attitude	-.31			
Observed Student Behavior				
Area 1 - 1st semester	-.51	-.41		-.23
Area 2 - 1st sem.	-.33	-.31		
Area 3 - 1st sem.		.20		
Area 6 - 1st sem.	.31			
Area 7 - 1st sem.				.20
Area 8 - 1st sem.	.47	.20		
Area 1 - gain	.25	.36		
Area 2 - gain	.26			
Area 3 - gain	-.34			
Area 7 - gain				-.21
Area 8 - gain	.23		.25	
Industry Ratio - 1st sem.	-.21			
Alone Ratio - 1st sem.	-.30			-.26
Active Ratio - 1st sem.		-.28		
Industry Ratio - gain	-.33			
Active Ratio - gain	.24			
Observed Student-Teacher Interactions				
Number of Interactions - 1st sem.				.27
Total time of Interactions - 1st sem.		.22		
Total number of interactions (Student Observations)		.25		.34
Student Work Output	-.26			

TABLE 15

SIGNIFICANT INTERCORRELATIONS BETWEEN STANDARDIZED ACHIEVEMENT SCORES AND OTHER DATA

(n=99, $p < .05$)

Standardized Affective Scores	Standardized Achievement Scores					
	M.A.	R.A.	A.A.	Snader Pre	Evans	Step
Attitude Pre Test	.28	.34	.41	.43	.46	.46
Attitude Gain		-.32	-.31	.33		-.31
Observed Student Behavior						
Area 1 - 1st sem.		-.22	-.29	-.30		
Area 2 - 1st sem.	-.45	-.41	-.29	-.51	-.48	-.30
Area 3 - 1st sem.	.33	.34	.31	.27	.52	.25
Area 4 - 1st sem.	-.28			-.26	-.39	-.22
Area 6 - 1st sem.					-.35	
Area 7 - 1st sem.	.21				.25	
Area 2 - gain				.31		
Area 4 - gain			.23			
Area 5 - gain				-.23		
Area 6 - gain		.30				
Area 7 - gain	-.20	-.22		-.20		
Area 8 - gain					-.27	
Industry Ratio - 1st	.33	.29	.24	.22	.60	.29
Alone Ratio - 1st					.22	
Active Ratio - 1st	-.25	-.31	-.24	-.23	-.38	
Industry Ratio - gain	-.27	-.27	-.29	-.29		
Active Ratio - gain		.21				
Observed Student-Teacher Interaction						
Total time of Interaction - gain					.24	
Student Production			.21		.36	
Teacher Judgment	-.27	-.27			-.53	

TABLE 16

SIGNIFICANT INTERCORRELATIONS BETWEEN STANDARDIZED AFFECTIVE TEST SCORES AND OTHER DATA

(n=99, $p < .05$)

	Standardized Affective Test Scores			
	Attitude		Dependence-Proneness	
Observed Student Behavior	Pre	Gain	Post	Gain
Area 2 - 1st sem.		.21		
Area 4 - 1st sem.	-.21			.49
Area 5 - 1st sem.	.23			
Area 6 - 1st sem.		-.27	-.28	
Area 8 - 1st sem.		-.27		
Area 2 - gain		-.30		
Area 4 - gain			-.22	
Area 5 - gain	-.24			
Industry Ratio - 1st sem.			.24	
Aloneness Ratio - 1st sem.		.26		
Industry Ratio - gain		.38		
Active Ratio - gain		-.26		
Observed Student-Teacher Interaction				
Number of Interactions - gain			.25	
Total time of Interactions - gain			.23	
Student Production of 10-page Units	.25			
Teacher Judgment	-.22		-.21	

TABLE 17

INTERCORRELATIONS BETWEEN OBSERVED STUDENT BEHAVIOR AND
(1) OBSERVED STUDENT-TEACHER INTERACTION, (2) STUDENT PRODUCTION
AND (3) TEACHER JUDGEMENT[1] AND BETWEEN STUDENT PRODUCTION
AND TEACHER JUDGMENT
($n = 99$, $p < .05$)

Observed Student Behavior	Observed Student-Teacher Interactions				Student Production	Teacher Judgment
	Number 1st sem.	Number Gain	Total Gain	Total Time		
Area 2 - 1st sem.	.25					.48
Area 3 - 1st sem.	-.22	.26	.33		.27	-.57
Area 4 - 1st sem.						.23
Area 5 - 1st sem.				.24		
Area 6 - 1st sem.	.20		-.23			.49
Area 7 - 1st sem.				.21		-.21
Area 8 - 1st sem.						.29
Area 1 - gain			.29			
Area 2 - gain						-.29
Area 4 - gain	.26					
Area 5 - gain					-.34	
Industry Ratio - 1st sem.	-.20		.27		.28	
Alone No. Ratio - 1st sem.	-.20	.23	.27			
Active Ratio - 1st sem.	.22		-.83			
Alone Ratio - gain					.21	
Active Ratio - gain			.29			
Student Production						-.33

device, either at the beginning or the end of the year and the gain of the child as measured with the same device during the year. This is an understandable phenomena in that the higher a child's score is on a test at the beginning of the year, the less chance he has of improving his score on the same test. Consequently, when a positive relationship is found between a given pre-test and some other variable there will frequently be a negative relationship accompanying the gain with respect to the test and the other variable. This phenomena is illustrated by the relationship between chronological age and the various kinds of observed student behavior.

Recall that the observation of the student behavior resulted in the child being classified in one of the following behavioral areas:

Area 1 - Alone, Industrious, Active
Area 2 - Alone, Unindustrious, Active
Area 3 - Alone, Industrious, Passive
Area 4 - Alone, Unindustrious, Passive
Area 5 - Group, Industrious, Active
Area 6 - Group, Unindustrious, Active
Area 7 - Group, Industrious, Passive
Area 8 - Group, Unindustrious, Passive.

There is a negative relationship between the chronological age of the student and the time he spent in both Areas 1 and 2 (r = -.51), (r = -.33). At the same time we find a positive relationship between the chronological age of the student and the increase in time spent in Areas 1 and 2 throughout the year, (r = .25, r = .26). There is also a positive relationship found to exist between chronological age and the time spent in Areas 6 (r = .31) and Area 8 (r = .47), as well as the gain in time spent in Area 8 (r = .23) and the gain in time spent actively (r = .24). On the other hand we find that the older was the child in the experimental class the less was his industry ratio (r = -.21), the less was his aloneness ratio (r = -.30), the less was his gain in time spent in Area 3 during the year (r = -.34) and the less was his gain in the industry ratio (r = -.33).

In many ways height age is related to behavior as is chronological age because there is a positive relationship between height age and chronological age. Height age is found to be positively related to the amount of time children spend in Area 3 (r = .20), the amount of time they spent in Area 8 (r = .20) and the amount of gain in time spent in Area 1 throughout the year (4 = .36). The greater the child's height age the less time he was found to spend in Area 1 (r = -.41), the less he was found to spend in Area 2 (r = -.31), the less was his activity ratio (r = -.28).

When measuring the amount of gain in height age during the year, it is interesting to note the positive relationship between the amount of height a child gained relative to the rest of his classmates and the amount of time he spent in behavioral Area 8, which is in an unindustrious active group (r = .25).

The final growth measure was weight age taken at the end of the year, which, like height age, is positively related to chronological age. According to the student observations the children who had the greatest weight ages in the experimental class were found to spend more time in behavioral Area 7 (r = .20). Weight age on the other hand was found to be negatively related to the amount of time the children spent in Area 1 (r = -.23), negatively related to the amount of time the children spent alone (r = -.26) and negatively related to the gain in time spent in behavioral Area 7 during the year (r = -.21).

D. Relationships Between Growth Measurements and Observed Student-Teacher Interaction

There seemed to be closer relationships existing between physiological characteristics of the children as measured by their weight and height ages and observed student-teacher interaction than between purely chronological age and student-teacher interaction. Height age, for example, was positively related to the total time student and teacher were observed to be interacting according to the three minute teacher observations (r = .22) and also positively related to the total time students and teacher were observed to be interacting according to the student interactions throughout the year (r = .25).

Weight age was also found to be positively related to the number of student-teacher interactions observed during the three-minute teacher observation samples (r = .27), and also the total number of student-teacher interactions observed in the student observations throughout the year (r = .34).

As will be seen later, these growth data are more closely related to the student-teacher interactions observed than are the other kinds of standardized data which have been gathered from the children, such as achievement test and affective test results.

E. Relationships Between Growth Data and Student Work Output

The only relationships found between growth data and students work output is a negative relationship between chronological age and the number of ten-page units (r = -.26). It seems as though the older the child in the experimental setting, the less materials he produced during the year.

There were no significant relationships found between growth data and teacher-judgment of students' self-selection ability.

F. Relationships Between Standardized Achievement Test Scores and Standardized Affective Test Scores (See Table 15)

There was a positive relationship found between the mathematics attitude test at the beginning of the year and every achievement test score obtained. Positive mathematics achievement at the beginning of the year was related to a high mental age (r = .28), a high reading age (r = .34), a high arithmetic age (r = .41), a high Snader Pre-test (r = .43), a high Evans test score (r = .46) and a high STEP Test score (r = .25).

A high Snader test score at the beginning of the year also seemed to predict a larger gain in attitude throughout the year (r = .33). However, high scores in some of the other achievement tests seemed to predict less of a gain in attitude throughout the year. There was a negative relationship between gain in attitude and reading age (r = -.32) and a negative relationship between gain in attitude and arithmetic age (r = -.31). The gain in attitude score was also negatively related to STEP test score (r = -.31).

There were no relationships between the dependence-proneness test scores and any of the standardized achievement test scores.

G. Relationships Between Standardized Achievement Test Scores and Observed Student Behavior

It is not surprising to find consistent patterns of relationships between the way students perform on written achievement tests and the way they are observed to behave in a class setting. There was a negative relationship found to exist between the amount of time the children were observed to spend in Area 1 and their reading age (r = -.22), their arithmetic age (r = -.29) and their Snader Pre-test (r = -.30). None of the standardized achievement test scores seemed to be related to any increase in time spent in Area 1 during the year.

The amount of time the child spent in Area 2 was negatively related to every achievement test score obtained. The negative relationships were found to exist between the amount of time the children spent in Area 2 and mental age (r = -.45), reading age (r = -.41), arithmetic age (r = -.29), Snader Pre-test (r = -.51), the Evans test (r = -.48) and the STEP test (r = -.30).

The relationship between the amount of time spent in Area 3 and scores on the standardized achievement tests is just the opposite from the amount of time spent in Area 2. There was a positive relationship between the percent of time spent in Area 3 during the first semester and mental age (r = .33), reading age (r = .34), arithmetic age (r = .31), Snader Pre-test (r = .27), Evans test (r = .52) and STEP test (r = .25).

Negative relationships were also found between the amount of time children were observed in Area 4 during the first semester and some of the standardized achievement tests. Such a negative relationship was found between percent of time in Area 4 and mental age (r = -.58), Snader Pre-test (r = -.26), Evans test (r = -.39) and the STEP test (r = -.22).

Children who scored high on the Evans Creativity Test were observed to spend less time in Area 6 (r = -.35).

A positive relationship was found between the amount of time children spent in Area 7 during the first semester and mental age (r = .21), and also the amount of time they were observed in Area 7 and their score on the Evans Creativity Test (r = .25).

Those children who scored high on the Snader Pre-test had a greater tendency to gain in the time spent in Area 2 (r = .31).

Those children who had a higher arithmetic age showed a greater tendency to gain in time spent in Area 4 (r = .25).

The children who showed diminishing amount of time in Area 5 throughout the year also tended to score higher on the Snader Pre-test (r = -.23). A high reading age seemed to be related to a larger gain in the time spent in Area 6 (r = .30).

Several of the standardized achievement test scores were negatively related to the amount of gain in time spent in Area 7 throughout the year. There is a negative relationship between the gain in Area 7 and mental age (r = -.21), reading age (r = -.20), arithmetic age (r = -.22), and Snader Pre-test (r = -.20).

There is a negative relationship between the gain in time spent in Area 8 throughout the year and the score on the Evans test (r = -.27).

There is a positive relationship between all of the standardized achievement test scores and the industry ratio. This relationship is similar to the relationship between these achievement test scores and the amount of time spent in Area 3, which is one of the industrious areas. This positive relationship is accompanied by a negative relationship between the achievement test scores and a gain in industry ratio, again illustrating that those children who scored highest on a pre-test have the least chance to gain when the top of the test is limited. The relationships were positive between industry ratio during the first semester and mental age (r = .33), reading age (r = .29), arithmetic age (r = .24), the Snader Pre-test (r = .22), the Evans test (r = .60), and the STEP test (r = .29).

The corresponding negative relationships between gain in industry ratio and standardized achievement tests show that smaller gains were obtained by those who scored higher in the mental age test (r = -.27), those who scored higher on the reading age test (r = -.27), those who scored higher on the arithmetic age test (r = -.29), and those who scored higher on the Snader pre-test (r = -.29).

The aloneness ratio was found to be positively related to the score on the Evans test (r = .22).

Those who scored well on the standardized achievement tests were found to have lower activity ratios. Children with the smaller activity ratios tended to score higher on the mental age test (r = -.25), on the reading age test (r = -.31), the arithmetic age test (r = -.24), the Snader pre-test (r - -.23) and the Evans test (r = -.38).

There was a positive relationship between the gain in activity ratio first semester to second semester and those who scored high on the reading age test (r = .21).

H. Relationships Between the Standardized Achievement Test Scores and Observed Student-Teacher Interactions

Those students who scored higher on the Evans Mathematical Creativity Test tended to have a greater gain in total interaction time with the teacher, (r = .24).

I. Relationships Between Standardized Achievement Test Scores and Student Work Output

The number of ten-page units produced by the students throughout the year appears to be related to at least two of the standardized achievement tests. The students who scored high on the California Arithmetic Test, measuring arithmetic age, tended to produce more written materials, (r = .21), as did those who scored high on the Evans Mathematical Creativity Test, (r = .36).

J. Relationships Between Standardized Achievement Test Scores and the Teacher's Judgment of the Student's Self-Selection Ability

The teacher judged the students in their self-selection ability as one, two, or three, a one denoting a highly competent student in the self-selection situation and a three noting a very incompetent student in the self-selection situation. The teacher judgments of the students' ability to work in self-

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selection situation turned out to be related to three of the mathematics achievement test scores.

There was a relationship between the teacher's negative judgment of the student's self-selection ability and the mental age, (r = -.27), the reading age, (r = -.27), and the Evans Creativity Test (r = -.53).

K. Relationships Between Standardized Affective Test Scores and Observed Student Behavior (See Table 16)

Table 3 shows the intercorrelations between the standardized affective test scores and some of the other data.

The score that the student received on the attitude pre-test is inversely related to the amount of time the student spent in Area 4 (r = -.21) and directly related to the amount of time the students spent in Area 5 (r = .23). It seems also that students scoring high on the attitude test at the beginning of the year were less likely to gain in percentage of time spent in Area 5 (r = -.24).

Those students who showed the greatest gain in attitude toward mathematics throughout the year as measured by the attitude scale, were found to spend a greater amount of time in Area 2 (r = .21), were also found to have a larger aloneness ratio (r = .26) and demonstrated a larger industry ratio gained throughout the year (r = .38). On the other hand those students who showed the greatest attitude gain were less likely to be found in Area 6 (r = -.27), or in Area 8 (r = -.27), or to gain in the amount of time spent in Area 2 (r = -.30). It also appeared that those students who showed the greatest attitude gain were less likely to have an increase activity ratio throughout the year (r = -.26).

The students who scored high on the dependence-proneness scale at the end of the year, which would indicate any more dependent person, tended to have the higher industry ratios (r = .24). They were also less likely to be found in Area 6 (r = -.28) and they were less likely to gain in the time they spent in Area 4 (r = -.22).

The students who gained the most on their dependence-proneness scale throughout the year also were found in Area 4 for a greater percent of the time (r = .49).

L. Relationships Between Standardized Affective Test Scores and Observed Student-Teacher Interactions

There were no relationships apparent between any of the attitude scale scores and the observed student-teacher interaction in the classroom.

The students who scored higher on the dependence-proneness post-tests, those students who were apparently more dependent, showed a greater gain in the number of student-teacher interactions as observed in the three-minute teacher observations (r = .25), had also a greater gain in the total time consumed by these interactions (r = .23).

M. Relationships Between Standardized Affective Test Scores and Student Production

The score the student got on the attitude test at the beginning of the year correlated positively related to the amount of material he produced throughout the year (r = .25).

N. Relationships Between Standardized Affective Test Scores and Teacher Judgment of Self-Selection Competency

The teacher-judgment of the students self-selection competency appears to be related to the attitude pre-test score (r = -.22) and to the dependence-proneness post-test score (r = -.21). This would indicate the student's showing a better attitude at the beginning of the year and claiming more dependence at the end of the year were also judged to be more competent in a self-selection situation by the teacher.

O. Relationships Between Observed Student Behavior and Observed Student-Teacher Interaction (See Table 17)

Table 4 shows intercorrelations obtained between observed student behavior and some of the other data.

Those students who were observed to require interaction with the teacher most frequently were also found to be in Area 2 a greater percent of the time (r - .25) and in Area 6 a greater percent of the time (r = .25), while they were less likely to be found in Area 3 (r = -.22). These same students had a greater tendency to increase their time in Area 4 (r = .26).

Those students who required the most frequent interactions from the teacher had lower industry ratios (r = -.20), had lower aloneness ratios (r = -.20) and higher activity ratios (r = .22).

Those students who showed the greatest gains in number of interactions required of the teacher between the first and second semester were also students who were found a greater percent of time in Area 3 (r = .26) and were found to be alone more often (r = .23).

The students who showed the greatest gain in total time required of student-teacher interactions were those students who were found in Area 3 more often (r = .33) and in Area 6 less often (r = -.23). These same students were more likely to gain in the time spent in Area 1 (r = .29) and more likely to gain in their activity ratio (r = .29). The students who gained most in total interaction time required had higher industry ratios (r = .27), were found to be alone more (r = .27) and were found to be less active (r = -.83).

From the student-teacher interaction data gathered from the student observations it appears that the students and teachers were more probably interacting when those students were in Area 5 (r = .24) and in Area 7 (r = .21).

P. Relationships Between Observed Student Behavior and Student Work Output

The students who spent more time in Area 3 produced more written materials throughout the year (r = .27). Those students who produced less materials were the ones who increased in the amount of time they spent in Area 5 (r = -.34).

The students who produced the most materials also had the highest industry ratios (r = .28) and tended to increase their time spent alone (r = .21).

Q. Relationships Between Observed Student Behavior and Teacher-Judgment of Self-Selection Competency

Those students who were judged by their teachers to be most competent in the self-selection situation were found in Area 3 more often (r = -.57) and in Area 7 more often (r = -.21). They were also students who tended to gain in the percent of time spent in Area 2 (r = -.29).

Those students who were judged to be least able to function in a self-selection situation were found to spend their time more often in Area 2 (r = .48), in Area 4 (r = .23), in Area 6 (r = .49), and Area 8 (r = .29).

R. Relationships Between Student Work Output and Teacher-Judgment of Self-Selection Competency

In Table 4 the students' work output is shown to be positively related to the teacher's judgment of the student's ability to perform in the self-selection situation (r = -.33). This would indicate that the teacher would tend to judge as better those students who tend to produce the most work.

This concludes Phase Two of the analysis of the data, examining the interrelationships between the various kinds of variables gathered in the study.

Conclusions derived from these analyses are found in the next chapter.

C. Teacher Role In The Experimental Class

The teacher of a completely individualized self-selection class finds himself in a very different role than the mathematics teacher in the conventional classroom. There are probably very few mathematics teachers at the junior and senior high school level who have operated in an individualized setting. Of the two teachers working in the experimental classes, the teacher of the seventh grade classes had had a limited amount of experience in individualized study from participating in a pilot project of the previous year. During that year the classes were individualized approximately 30% of the time. The teacher in the eighth grade classes had had no experience in working with individualized classes previous to this project.

Both of the teachers in the experimental classes expressed a concern for their lack of training and experience in working with individualized classes.

The three-minute teacher observation samples help to illustrate the way in which the teacher's time was spent in the experimental class. Table 18 shows the percent of time that the teachers were observed to be acting in the various roles of helping individual students, observing the class, admonishing students, looking for materials, and a general category which would include a large variety of behaviors such as returning completed papters, etc.

From the data in Table 18 it appears as though the teachers at both grade levels learned how to spend a larger percent of the time working with individual students as the year went on. Or it may be that the students required additional teacher help as the year progressed. An encouraging observation of the teacher behavior data is the relatively small amount of time the teacher had to use in looking for material. A critical aspect of nurturing inquiry is probably the interval between the time the child asks the question and the time he receives the information pertinent to the answer of that question.

The teacher was shown in the previous table to spend about three-quarters of his classroom time working with individual children. From the student observations it was possible to estimate the percent of the time the teacher spent with children who were behaving in particular behavioral areas. Table 19

TABLE 18

PERCENT OF TIME THE TEACHERS WERE OBSERVED TO BE IN VARIOUS ROLES FROM THREE-MINUTE TEACHER OBSERVATIONS

	7th Grade		8th Grade	
	1st sem.	2nd sem.	1st sem.	2nd sem.
1. Helping individual students	72	80	62	75
2. Observing class	11	6	15	8
3. Admonishing Students	2	0	2	0
4. Looking for Material	6	6	13	10
5. Other various Returning papers	9	8	8	7

TABLE 19

PERCENT OF TIME THE TEACHERS SPENT WITH CHILDREN IN VARIOUS BEHAVIORAL AREAS FROM STUDENT OBSERVATION SAMPLES

	7th Grade		8th Grade		
	1st sem.	2nd sem.	1st sem.	2nd sem.	5th Grade
Area 5 Industrious-Active	32	30	31	42	43
Area 6 Unindustrious-active	19	14	23	14	12
Area 7 Industrious-Passive	34	55	34	41	42
Area 8 Unindustrious-Passive	15	1	12	3	3

shows the percent of time the teacher spent with children in the various behavioral areas. From the table we can see that the seventh grade teacher's time was distributed to industrious students about 66% of the time during the first semester, and 85% of the time during the second semester. The percentsare extremely similar for the eighth grade teacher. This is an indication of the fact that the experimental classes as a whole became more industrious as the year progressed.

The table also shows that the seventh grade teacher spent 51% of the time during the first semester with active students and 44% of the time during the second semester with active students. Thus, it seems that there is little change in the activity level from first to second semester for the seventh grade. A slight increase in activity level is observed in the eighth grade.

All of the observations of teachers interacting with students as observed in the student observations were classified as group classifications because if the observer saw the student interacting with the teacher, then he could not classify the student as being alone. The data do not allow analysis of how much time the teacher spent working with individual students and how much teachers spent working with two or more students at the same time. It is the feeling of the experimental teachers, however, that it became extremely difficult throughout the year to work with larger groups of students in the individualized class.

D. Student Preferences of Materials

1. MOST SELECTED TOPICS

Table 20 shows the units which were selected and completed by five or more students in the various sub-groups of seventh grade girls and boys and eighth grade girls and boys. The titles of these topics can be found in the materials list in Appendix 1. A few of these most popular topics will not be found in the list. Those with sub-scripts of five will indicate fifth grade materials; for example, 112_5 indicates a fifth grade item of material which deals with the same mathematical idea as does 112 on the seventh and eighth grade material list. Also EA 110 refers to the School Mathematics Study Group, fourth grade unit which was reproduced and available to the students in the classroom. The item entitled Student Produced Materials, which was extremely popular, indicate a rash of materials produced by the seventh graders themselves at a time when they were encouraged to conceive of ideas from materials and were provided with ditto carbons in order to manufacture them. The item entitled, Aexagons, that was so popular among the eighth grade girls was simply introduced to the class by the teacher. There were many activities that the students in the experimental classes engaged in

TABLE 20

UNITS WHICH WERE COMPLETED BY 5 OR MORE STUDENTS IN THE VARIOUS SUB-GROUPS

	7		8			7		8	
	G	B	G	B		G	B	G	B
105	5				822			9	
107	16	12		5	Student Produced	67	84		
108	19	8							
109	20	9			P-12	7			
1125	8	6			B75-P	9			
124	10				B72	9			
1305	5				B78	9	7		
152	11	8			B82				9
170	14			6	B92	12		15	10
193	5	13			B212	10			
EA110	46	14		11	B250		12		
302				7	B252		7		
307	8	7			B253		11		
314		6			1037	8	14		
322		5			Flexagons			16	
401	8	5							
522	17	44		5					
601	5								
605	8								
610	10	8							
806	12	10							
809	5	7							
811	12	7							
815			17						
817			14	5					
818			6						
819			15	5					
820			5						

that never were recorded. For example, toward the end of the year there was a larger amount of time spent playing chess and playing some other similar kinds of games. When these did not require written work they were not recorded. There were also some program units which were received very late in the year and did not get assigned numbers and recorded.

The problem of attempting to record precisely what the child does in an experimental setting such as this poses somewhat of a dilemma. The person most able to record what the child is doing would probably be the child himself. This would seem to require some sort of a daily log. This idea was tried during the pilot study of the previous year and met with a great deal of resistance from the students. To some extent, apparently, when the child is asked to stop and reflect about what he is doing, it interferes with the interest in what he is doing. So in a sense a daily log requirement would be a self-defeating proposition. On the other hand the task is extremely large for a teacher to attempt in a daily log the activities of the children. To hire clerical assistance or an observer to do this would be rather expensive. So the problem of recording precisely what children do is a problem which will not be solved without a great deal of expense.

2. FAVORITE TOPICS OF STUDENTS

Table 21 shows the response that was given to the question, "Which topics have you found that you liked best during the year?" It can be noted that the seventh grade in general found a bigger variation in favorite topics than did the eighth grade. This is due in part to the fact that many eighth graders spent most of their time studying only algebra.

3. STUDENT REACTION TO SELF-SELECTION

It is difficult to get an accurate assessment of the students' feelings about the experimental project. For one thing, the halo effect acting on the experimental class certainly has to be accounted for. On the other hand many of the students who had attended the University School in the past years are getting somewhat used to the experimentation of one kind or another. In addition, most of the assesements were gathered by the teachers of the students. These teachers had the eventual task of evaluating the students' work and the students realized this. To some extent, then, student reactions to the question, "On the whole, what do you think of self-selection in mathematics" has to be considered in the light of the various factors which could affect the student response. Table 22 shows the results when students who were asked the question at the end of the year, "On the whole, what do you think of self-selection in mathematics." It should be noted here that seventh grade acted much more positively to the question than did the eighth grade. Accompanying the seventh grade responses were found remarks such as, "It gives a person a

TABLE 21

TOPICS SELECTED AS MOST ENJOYABLE BY STUDENTS

7th Grade		8th Grade	
Boys	Girls	Boys	Girls
Geometry - 5	Numeration - 7	Algebra - 10	Algebra - 17
Chess - 4	Factors & Primes - 6	Geometry - 10	Logic Puzzles - 10
Minivac - 4	Chess - 5	Minivac - 9	Geometry - 4
Measurement - 3	Logic Puzzles - 5	Logic Puzzles - 4	Computation - 3
Graphs - 2	Geometry - 4	Slide Rule - 3	Probability - 2
Logic Puzzles - 3	Graphs - 3	Probability - 3	SMSG 8th - 1
SMSG 7th - 1	Probability - 2	Computing - 2	Fractions - 1
Probability - 1	Modular Arith - 2	Adding Mach. - 1	Graphing - 1
Numeration - 1	Algebra - 2	Boston College - 1	Percent - 1
Surveying - 1	Matrices - 1	Sets - 1	Topology - 1
Temac - 1	Parabolas - 1	Topology - 1	
Statistics - 1	Fractions - 1	Numeration - 1	
Exploring Math Ideas - 1	Reading - 1		
	Curve Stitching - 1		
	Short Cuts - 1		
	Sets - 1		

chance to go back and pick up what he missed," or "You don't have to worry about not doing well.", or "It gives you a chance to work on things that you are interested in."

TABLE 22

STUDENT REACTIONS TO THE QUESTION: ON THE WHOLE, WHAT DO YOU THINK OF SELF-SELECTION IN MATHEMATICS?

		Positive	Positive with Reservation	Negative
7th Grade	Boys	13	5	3
	Girls	13	9	1
8th Grade	Boys	0	16	8
	Girls	4	7	12

Frequently accompanying the eighth grade responses were remarks such as, "We don't learn as much in this situation," "I can't work under these conditions," or "A regular class is better because I need direction."

In general the seventh grade classes were run with a slightly tighter reign than were the eighth grade classes. There was more insistence in the seventh grade classes that students maintain at least the busy appearance and less conglomerate activity. Strangely enough, too, the eighth graders in this study were the seventh graders in the pilot study who also showed more enthusiasm toward the project in general than did the eighth graders of the previous pilot study year. It is probably safe to assume that there are some characteristics posessed by the eighth grade that are not possessed by the seventh grade, and that these characteristics have serious implications for the nature of the curriculum in these grades.

4. ANALYSIS OF THE DATA GATHERED IN THE FIFTH GRADE EXPERIMENTAL CLASS

As was mentioned earlier the fifth grade teacher asked to participate in the experiment. No control class was available, but arrangements were made so that the fifth grade teacher could receive a large supply of materials and was provided with research assistant to gather materials and data. The data that were gathered in the fifth grade were not necessarily the same as they were in the seventh and eighth grade experimental classes. However, several of the same variables were measured.

Table 23 shows the significant intercorrelations between some of the different kinds of variable as measured in the fifth grade class. The top part of the table contains the intercorrelations relating to observed student behavior in class and growth measurements. A positive relationship was observed to exist between height age and weight age and the amount of time students were observed to be in Area 6. This relationship did not exist between chronological age and time spent in Area 6. So one can conclude that those children who were growing fastest, when measured by height and weight, were more likely to be found in an unindustrious-active group within a class than those children who were growing slower. A positive relationship was found between the amount of gain in weight age throughout the year and the amount of time the children were observed to be in Area 7, which is an industrious-passive group. This seems to indicate that those children who were gaining fastest in weight throughout the year were more likely to be found in an industrious-passive group. The relationship between weight age and industry ratio is an inverse relationship. This corresponds with the fact that children with larger weight ages are generally found in an unindustrious area (Area 6).

TABLE 23

SIGNIFICANT INTERCORRELATIONS BETWEEN 5th GRADE VARIABLES
(n = 22, $p < .05$)

	Area 3	Area 6	Area 7	Area 8	Ind. Ratio	Alone Ratio	Active Ratio
H.A. Pre		.49					
W.A. Pre		.74			-.47		
W.A. gain			.48				
A.A. Pre	.49						
Arith-Fund Pre	.49						
Arith.Fund Gain					.49		
R.A. Pre	.56				.44		-.44
Attitude Gain				-.49		.46	

The middle part of the table shows the relationships which were found to exist between scores on standardized achievement tests and observed student behavior in the experimental class. There is a positive relationship between several of the test scores and the percent of time that the students were observed in Area 3, which was an industrious-passive person working alone. The clearest positive relationships are between the children working in Area 3 and their arithmetic age at the beginning of the year (r = .49), the fundamental section of the arithmetic test at the beginning of the year (r = .49) and their reading age at the beginning of the year (r = .56).

Accompanying those relationships we see a positive relationship between the industry ratio and the reading age at the beginning of the year (r = .44) and the amount of gain on the fundamental section of the arithmetic test (r = .49).

Those children who were the best readers at the beginning of the year were found to spend their time less actively in class than those children who were not such good readers (r = -.44).

The bottom row of the Table 23 shows relationships between observed student behavior in class and the standardized affective test scores. It was found that the children who gained most in their attitude scores throughout the year were less likely to be found in Area 8, which is the unindustrious-passive group (r = -.49) and were more likely to be found alone (r = .46).

The list of the materials available in the fifth grade class will be found in Appendix 6.

VI. CONCLUSIONS AND IMPLICATIONS

The purpose of this project was to observe and analyze the effects of allowing junior high school age children to self-select their own mathematics program within a highly diverse and rich environment. Two kinds of analyses have been made. The first kind concerned comparisons between the children in the experimental group and children in traditional control groups in the dimensions of mathematics achievement, attitude toward mathematics, and dependence proneness. The second kinds of analyses concerned the behavioral characteristics of the children who were in the experimental group, the teacher role in the experimental class, and the nature of materials which seemed to be most interesting to junior high school children.

A. Conclusions Regarding Comparisons Between Control and Experimental Groups

The experimental group consisted of 50 seventh grade students and 49 eighth grade students in the University School, University of Michigan. These students met in classes of size approximately 25 for four periods per week of 55 minutes each. In the classroom were a large variety of mathematical materials, ranging in difficulty level from approximately fourth grade to college level. Throughout the entire year all the children were required to self-select mathematical activities in which they wish to engage, usually on an individual basis. No specific materials, ideas or concepts were required to be pursued by the student nor was there any sequence or pace imposed upon the students. The teacher in the classroom operated in such a way as to attempt to maximize the amount of effective work on the part of each child.

The control classes consisted of four seventh grade classes and four eighth grade classes in Forsythe Junior High School, Ann Arbor, Michigan. The Ann Arbor Public School system operates in a four-track system in junior high school. One control class was selected from each track at each grade level. There were a total of 172 children in the control group. All of the control classes were using School Mathematics Study Group texts and operating in a conventional manner for five 45-minute periods each week.

B. Differences in Achievement Between Experimental and Control Samples

There were no significant differences in achievement in any of the samples compared at the beginning of the year. At the end of the year some of the control samples scored significantly higher in achievement than did the corresponding experimental samples, while none of the experimental samples scored significantly higher than did the control samples. The seventh grade boys and girls in the control classes scored higher than did the seventh grade boys and girls in the experimental classes. Both the bright boys and bright girls in the control samples (I.Q. 115 or greater) scored significantly higher on the achievement test at the end of the year than did the bright boys and girls in the experimental classes. On the other hand no significant differences in achievement were found to exist between the eighth grade samples and between the slow samples (I.Q. = 114 or below). The differences by grades can be expected because of the differences in brightness between the control and experimental samples. The differences by brightness cannot be.

Conclusion 1. Bright students (115 I.Q. and above) did not learn as much in the self-selection class as they did in the conventional class.

Conclusion 2. Slow students (114 I.Q. and below) learned equally well in either the self-selection class or the conventional class.

C. Differences in Attitude Between Experimental and Control Samples

Some of the experimental samples had relatively higher gains in attitude than did the corresponding control samples, while none of the control samples had relatively higher gains than did their corresponding experimental samples. The seventh grade boys in the experimental classes experienced a slight gain in attitude, while the seventh grade boys in the control classes experienced a slight loss in attitude. The differences between the experimental and control groups were significant at the beginning of the year, but not at the end of the year, which resulted in a relatively higher gain for the experimental seventh grade boys than for the control seventh grade boys.

The seventh grade girls in the experimental and control groups had no differences in attitude at the beginning of the year. During the year the girls attitude in the experimental group increased greatly, while the girls attitude in the control group decreased some. The differences at the end of the year were significant. Therefore, the seventh grade girls had a relatively higher increase in attitude in the experimental class than they did in the control classes.

The slow girls in the control classes were significantly higher than the experimental classes at the beginning of the year, but their attitude decreased throughout the year such that at the end of the year there was no difference. Therefore, the slow girls in the experimental classes experiences relatively lower losses than did the girls in the control classes.

Conclusion 3. The seventh grade students and the slow girls (114 I.Q. and below) developed better attitudes toward mathematics in the self-selection class than in the conventional class.

There were no differences in either the pre or post dependence proneness scales when the experimental and control samples were compared.

D. Conclusions Regarding the Data Gathered Within the Experimental Groups

The second major concern of this project was to gather information about the kinds of behavior children display when placed into a self-selection mathematics environment. The project was interested in discovering the characteristics of children who display certain kinds of behavior and find the most effective student and teacher roles in a self-selection class. In addition, the project was interested in determining the kinds of materials that junior high school students find most interesting and enjoyable.

An observer was employed by the project to observe the students within the experimental setting. The observer was in the classroom and observed each individual child five times during each experimental class period. The dimensions of the observed behavior were gregariousness, industry, activity, and student-teacher interaction. The students' behavior was classified in one of two classifications according to each of the first three dimensions above. This allowed a two by two by two cell of behavior classifications referred to as behavioral Areas 1 through 8. As can be seen in Table 6 and 7 the children were observed to be most frequently in behavioral Area 3, which is alone, industrious-passive category where the passive description refers to reading and writing or less active than reading and writing. This kind of behavior is highly desirable behavior from the point of view of the learning teaching situation, as it is probable that in this kind of behavioral area the most effective individualized work can be done. The different samples in the experimental group varied somewhat in the amount of time they were observed in this area with the eighth grade girls spending an average of 48% during the first semester in this area, while the eighth grade boys spend only 28% of their time in this area.

The second most frequently observed behavior was behavioral Area 6, in which the students were in an unindustrious-active group. This would not be an appropriate behavioral area in which to expect effective learning to take place. Again the groups varied considerably in this area with the eighth grade boys spending 32% of their time in such a manner, while the fast girls spent only 16% of their time in this way.

Thus the two most frequently observed behavioral areas appear at what might be called the extremes of the behavioral descriptions of the study, the first being the most favorable kind of behavior, while the second might be called the least favorable kind of behavior. It should not be assumed that the students should be expected to be passive and alone all of the time as they are in behavioral Area 3. A great deal of good learning could take place in a more active situation or in group situations. However, for the maintenance of reasonably effective classrooms there should be a good deal of individual work in a somewhat passive state.

The extreme kind of behavior observed during the first semester diminished during the second semester. The sample means for both Area 1 and Area 6 are almost invariably smaller than in the first semester while there tended to be increases in students observed in behavioral Area 5, which is an industrious-active group.

Conclusion 4. As the year progressed, the children tended to work more industriously and also tended to work more in groups.

When the sample means were compared for the different behavioral areas by sex, some clear-cut differences emerged. Boys were found to be in Area 2, which is unindustrious-active-alone, much more often than were girls, while girls were observed to be in Area 3 much more often than boys. For the eighth grade the boys were found to be in Area 4, which is alone-unindustrious and passive more often than were girls. Area 5 was observed as the behavior of fast boys much more often than fast girls. Boys were observed in Area 6 and in Area 8 more often than were girls. Areas 6 and 8 are unindustrious groups, active and passive.

Conclusion 5. Girls were more industrious, less active and more alone than were the boys.

When the samples are compared by brightness in terms of the percent of time in the various behavioral areas, some differences emerge. Slow boys were observed to be in Areas 2 and 4 more often than were the fast boys, indicating slow boys would spend more time unindustriously and alone than did the fast boys. The fast girls were observed in Area 3 more often than were the slow girls. The fast boys were found in Area 5 more often than were slow boys, while slow girls were found in Area 6 more often than were fast girls.

Conclusion 6. The slow students were more likely to be observed as unindustrious than were the fast students.

There were also differences found between the various samples when the samples were compared by grades. The seventh grade students were more likely to be observed in Areas 1 and 2, which involved alone-active behavior, than were the eighth grade. The seventh grade was also more likely to be observed in Areas 5 and 7, while the eighth grade was more likely to be observed in Areas 6 and 8.

Conclusion 7. Seventh grade students, when alone or in groups, were more likely to be industrious than were eighth grade students.

Additional information can be derived by examination of the industry ratios (Table 8) in which only the dimension of industry is considered from all of the observer's observations. The industry ratios of all of the samples increased from first semester to second semester. This further supports Conclusion 4 that all kinds of students profited from the experience in terms of learning how to spend their time in a more industrious fashion while in the classroom.

There were extensive differences in the amount of industrious time the various kinds of students spent within the class, ranging from 40% for the eighth grade boys during the first semester to 74% for the seventh grade girls during the second semester. Remembering that these are mean scores for samples, the industry ratios for individual children ranged from a low of approximately 12% to a high of 100%.

While the students were becoming more industrious throughout the year, they were also becoming less alone stated in Conclusion 4. This might be an expected phenonema, as half of the students were new to the school at the beginning of the seventh grade so that as the year progressed, the students got to know each other better and might be expected consequently to work together more often.

As stated in Conclustion 5, girls were found to work alone much more frequently than were boys. This difference in behavior by sex is even more striking during the second semester than during the first, which seems to indicate that girls tended to continue to work alone throughout the year, while the boys tended to work together as the year progressed.

Conclusion 8. The seventh grade boys were found to work alone more often than were the eighth grade boys during both semesters.

This difference could conceivably result from the increased maturity of the eighth graders, but it also in part results from the slightly different classroom procedures used by the teachers. The seventh grade teacher insisted on students working alone more often, than did the eighth grade teacher.

Conclusion 9. During the second semester the fast girls were found to be alone more often than were the slow girls.

In many cases those samples which were significantly superior in industry were also superior in aloneness, allowing the conclusion that aloneness and industry are closely related to each other.

In the observed active behavior, as shown in Table 10, there was a lesser tendency for a change from first semester to second semester, but (all except two) of the samples decreased in their active behavior.

Conclusion 10. Boys were invariably found to be more active than were girls.

Conclusion 11. Seventh grade girls were found to be more active than eighth grade girls during the first semester.

Conclusion 12. The slow girls were found to be more active than the fast girls during the second semester.

Thus, activity seems to be inversely related to industry and aloneness.

E. Conclusions Regarding Student-Teacher Interaction

Each time the observer made an observation of a student one of the dimensions of information gathered was whether or not the student was interacting with the teacher at the instant of observation. The mean percent of total class time the members of the various samples were observed to be with the teacher is shown in Table 11, and called Total Time from Student-Observation. In addition to this more extensive data regarding student-teacher interaction was gathered. Immediately after the observer had completed the second, third and fourth student observations for the entire class he watched the teacher for three minutes and recorded more precisely what the teacher did and with whom. These data were then classified according to the number of times that the teacher was observed to interact with each student and also the number of ten second intervals during which they were interacting.

The two kinds of data gathered relating to student-teacher interaction tended to yield contradictory results in at least two instances. When comparing the samples by grade, the total time of student-teacher interaction for each child during the entire year indicated that seventh grade girls spent significantly more time interacting with the teacher than did the eighth grade girls. However, the data gathered in the teacher observations indicated that during the second semester the eighth grade girls spent significantly more time than did the seventh grade girls interacting with the teacher. One probable reason for this inconsistency might be the changes in patterns of the teacher behavior in the classroom, such that as the year progressed the eighth grade teacher tended to spend more time with the girls in the class, while the seventh grade teacher tended to spent more time with the boys. It is clear from the data in Table 7 that while the eighth grade teacher spent equal time with boys and girls during the first semester, there was a significant shift in both the number of student-teacher interactions and the total time of student-teacher interaction in favor of the girls in the eighth grade class during the second semester. Another apparent inconsistency arises when comparing the samples by sex. The slow boys were observed to be interacting significantly more during the total year on the basis of the data gathered on the student observations than were the slow girls. However, during the second semester the slow girls required interaction with the teacher more than did the slow boys on the basis of the teacher observation data. Again this phenomena could result from shifts in teacher behavior during the year.

On the basis of the student observations there is an indication that the slow boys required more student-teacher interaction than did the fast boys.

On the basis of all of these comparisons the only conclusion that might be drawn with confidence is the fact that the student-teacher interaction in the eighth grade made a considerable shift from first to second semester, such that the teacher spent more time with the eighth grade girls in the class and less time with the boys in the class.

The teacher observations allowed tentative conclusions to be drawn about not only which kinds of students the teachers spent their time with as was just discussed, but also what kinds of apparent roles the teacher was playing. Table 18 includes the data regarding the way the teacher behaved in the class. It is obvious that the vast majority of the teacher's time was spent in helping individual students. In addition, it is clear that as the year progressed the teacher spent more and more time helping individual students. As was noted earlier neither of the teachers had had any formal training in working with individualized classes, although one of the teachers had taught in the pilot project of the previous year. Both of the teachers stated need for training of the kind that core teachers receive. Both of the seventh and eighth grade classes were engaged in core two hours a day, and in those classes the students could be observed to be working as a group on individual tasks. In the mathematics class while the students were working on individual tasks, they by no means had any group orientation. The skill of a teacher to have a class operate in this fashion is probably a learned skill and can probably be taught to mathematics teachers.

F. Conclusions Regarding Student Performance on Standardized Achievement Tests

When the performance of the various samples within the experimental group were compared by brightness, grade and sex on the Standardized Achievement Tests, only a few surprising results were discovered. It is not surprising that the fast students consistently scored better than the slow students on all of the measures. The eighth grade students scored higher than the seventh grade students on the Snader test, both at the beginning and at the end of the year. However, there were no differences between the seventh and eighth grade performance on either the STEP test or the Evans Mathematical Creativity Test.

Conclusion 13. The Snader test, which is more skill oriented than the other tests is more sensitive to the differences in grade of the students than are the STEP and Evans tests, which deal more with general concepts and understandings as well as creative behavior.

When the experimental samples were compared by sex, no difference was found in either the Snader test or the STEP test. However, every experimental sample of girls scored higher than did the male counterparts on the Evans Mathematical Creativity test. This is consistent with Evan's findings at grades seven and eight. However, Evans did not find the same kinds of sex differences in grades five and six. These data served to add to the uncertainty about the existence of differences in sex in creative behavior as the majority of the research efforts have seemed to indicate that there are no sex differences.

G. Conclusions Regarding Comparisons of the Experimental Samples Affective Test Results

When the experimental samples were compared by grades there were no differences in the attitude tests at the beginning of the year, but at the end of the year the seventh grade girls scored significantly higher than did the eighth grade girls.

Conclusion 14. The seventh grade girls had a relatively more positive experience in the experimental class than did the eighth grade girls.

The data regarding the dependence proneness test were not available for the seventh grade at the beginning of the year. At the end of the year, however, the seventh grade boys scored significantly higher than did the eighth grade boys, indicating eighth grade boys had more feelings of independence than did the seventh grade boys. This is consistent in view of the fact that the teacher in the eighth grade spent increasingly less time with the eighth grade boys.

When the affective tests were compared by sex, there were no differences in attitudes at the beginning of the year. By the end of the year, however, the seventh grade girls scored significantly higher on attitude than did the seventh grade boys while the eighth grade boys scored higher than the eighth grade girls.

On the dependence proneness test during both semesters the eighth grade girls scored higher than the eighth grade boys, and the slow girls scored higher than the slow boys, indicating that both the eighth grade girls and the slow girls said that they felt more dependent in the class. This is consistent in view of the fact that the girls required more of the teacher time than did the boys in the eighth grade.

Conclusion 15. The experimental setting had more effect on the attitudes of girls than it did on boys. The boys' scores tended to remain constant throughout the year, while the seventh grade girls' scores increased considerably and the eighth grade girls' scores decreased considerably.

It is difficult to draw any conclusions about the effect of the experimental setting on the scores of the dependence proneness test although there is some indication that the greater the student-teacher interaction accompanies greater feeling of dependence.

H. Conclusions Regarding Student Reactions to Material

Table 20 shows the numbers of the most frequently selected materials by the various sub-groups in the experimental group, separated by grade and sex.

Table 22 lists the topics that the students said they preferred the most. The differences between the grades is the most striking difference; while the eighth grade appeared eager to get into some more formal topics such as algebra and geometry, the seventh grade were more willing to experiment with varieties of topics. Probably the topics were more new to the seventh grade than they were to the eighth grade who had been in a somewhat similar position the year before. This points up the problem of continuing to develop a new and varied collection of materials in a classroom such as this one.

The results of the student material preferences are consistent with the responses of the students when asked at the end of the year: "What do you think of self-selection in mathematics?" The seventh grade students were overwhelmingly in favor of self-selection, while the eighth grade students were somewhat opposed to the experience. It seems that while the seventh grade students spent more time industriously and alone throughout the year and had found a bigger variety of materials to work in, they felt they had a more satisfying experience. It borders on irony that it is the seventh grade which did not compare favorably to the control classes, while the eighth grade performed in a fashion similar to that of the control classes.

I. Conclusions About the Fifth Grade Experimental Class

Although the fifth grade class was smaller and the observations were fewer some interesting patterns still emerge.

There are indications of relationships between rate of physical growth and classroom behavior. Those students who were growing the fastest were less inclined to be observed as industrious.

On the other hand, those students who performed well on standardized achievement tests were more likely to be observed as industrious.

Finally, those students who were industrious and alone during the year showed a gain in attitude during the year.

It was the subjective judgment of observers that the fifth grade class was much more competitive and peer oriented in their work than were the older students. The entire class was much more likely to follow the choice of one strong student than were the seventh and eighth grade students.

A couple of incidents should be recorded from the class. On one day the students were shown a set of SOMA cubes. They soon requested to build their own sets so a session was planned with the Industrial Arts Teacher and eight of the fifth grade boys set up an assembly line. The eight boys produced more than 1200 1 in. cubes in one hour completely sanded and inspected with quality controls.

On another occasion three of the boys became interested in a programmed algebra text. In a fiercely competitive situation they completed three volumes in a matter of a few days. A couple of the girls in the class also demonstrated an interest and ability to do algebra.

J. Implications and Needed Research

This project has demonstrated that, for a part of the school population, a totally individualized self-selection program is just as effective as a very good conventional program.

Yet the program failed to meet the needs of the brightest students in the seventh and eighth grades as ways were not found in this program to challenge the bright children to learn to their capacity and to have positive feelings about it.

The expressed feelings of the students both in favor of and opposed to the program showed that the program was internally inconsistent by not allowing the student who desired a structured, guided program in a group setting to be able to select that option. All staff members associated with the project feel it would be more successful if all students were included as a result of their own choice.

The major implication from this study is that self-selection can be an important aspect in the development of a more appropriate mathematics curriculum which will better meet the individual needs of children. The implication holds more clearly for the slow and average children than for the bright children.

Another implication is that there remains a serious shortage of appropriate materials for:

1. slower learning adolescent children who have been by-passed by the sequence of ideas in the curriculum;

2. active learning experiences which capitalize on the energy and enthusiasm of adolescent boys;

3. independently oriented bright students who wish to progress at a faster pace than normal.

The final implication is that there are roles for the teacher and the student which are different than the conventional roles which might lead to the utilization of the broader values of the curriculum including attitudes, study habits and creative behaviors.

In order to determine more precisely the nature of the alternative roles of teachers and students, much more research is necessary. It is imperative that more precise theory be developed about the nature of adolescent growth and development and its effect on classroom behavior and learning. Much work is now in progress dealing with interaction analysis between teacher and class when the class is participating as a group. The same kind of attack is necessary to investigate the interaction of teachers and individual children working in an individualized classroom setting.

The results of this project suggest the need to replicate the project embodying several adjustments which might provide more satisfactory outcomes in the experimental classes:

1. Include in the experimental classes only those students who choose to be there and who demonstrate appropriate classroom behavior.

2. Expand on the activity-oriented materials which allow the students more vigorous physical participation.

3. Expand the use of games and game theory to exploit the intrinsic motivational characteristics of games.

4. Incorporate more total group interaction where the entire class engages in reporting, listening, evaluating and planning.

5. Provide access to small discussion groups particularly for the brighter students to increase the stimulation they can provide for each other.

6. Develop more diagnostic instruments which will allow the student to learn more precisely what he has learned and when he has learned it.

7. Develop further the observation techniques which will allow measurement and analysis of interaction between teacher and individual student.

The purpose of this project was not to prove that the mathematics curriculum should or should not be based on a self-selection concept. This is a decision that rests with those who determine the nature of the curriculum.

It was the purpose of this project to gather information about the effects of the use of self-selection on the achievement, attitude and dependence-proneness of children in junior high school mathematics and information about materials used and classroom behavior in such a program.

The use of self-selection was neither completely disastrous nor completely successful. For many students the concept seemed very appropriate and for many others it was very unsatisfactory.

The majority of students lie between the extremes where the influence of the teacher and the situation will largely determine whether or not the experience will be successful. Therefore, the description and measurement of appropriate interaction between teacher and student becomes a most imperative area of research.

APPENDIX I. MATERIALS CONTAINED IN EXPERIMENTAL CLASSROOMS

UNITS IN LARGE CABINET

Arithmetic

101	Numeration (SMSG EA)
102	Extending Systems of Numeration (SMSG EB)
103	Numeration (SMSG)
104	Systems of Numeration (Md.)
105	Symbols for Numbers (B.S.)
106	Numeration Bases (K.P.K.)
107	Other Bases in Arithmetic (Ginn)
108	How the Egyptians wrote Numerals
109	How the Ancient Greeks Wrote Numerals
110	Natural Numbers (Md.)
111	Counting (BS)
112	Whole Numbers (SMSG)
113	Nature of Addition and Subtraction (SMSG EA)
114	Properties of Addition and Subtraction of Whole Numbers (BS)
115	Techniques of Addition and Subtraction (SMSG EA)
116	Techniques of Addition and Subtraction (BS)
117	Nature and Properties of Multiplication and Division (SMSG EA)
118	Properties of Multiplication and Division of Whole Numbers (BS)
119	Techniques of Multiplication and Division (SMSG EA)
120	Techniques of Multiplication and Division (BS)
121	Introducing the Integers (SMSG EC)
122	A New Set of Numbers (BS)
123	The System of Integers Under Addition (Md.)
124	How We Use Parentheses in Mathematics (W)
124	Division of Whole Numbers (S)
130	Developing the Concept of Fractional Numbers (SMSG EA)
131	Ratio and Proportion (BS)
132	The Number System of Ordinary Arithmetic (Md.)
133	The System of Rational Numbers (Md.)
134	Decimal Notation (Chap. 14, BS)
135	Addition and Subtraction of Fractional Numbers (SMSG EB)
136	Addition and Multiplication of Rational Numbers (BS)
137	Multiplication and division of Fractional Numbers (SMSG EC)
138	The Non-negative Rational Numbers (SMSG)
139	The Rational Number System I (SMSG)
140	Percent Notation (BS)
141	Ratio, Percent, and Decimals (SMSG)
142	Rational Numbers and Their Coordinates (SMSG)

UNITS IN LARGE CABINET (Continued)

Arithmetic

143	So These Are Fractions (Prentice)
144	Subtraction and Division of Rational Numbers (BS)
145	Scientific Notation, Decimals and Metric Systems (SMSG)
146	Square Root of Whole Numbers and Decimals
147	Base Ball
150	Factors, Primes Common Denominators (SMSG EB)
151	Factoring and Primes (SMSG)
153	The Latest Dope on Primes (SMSG)
154	Prime Numbers
170	Modular Arithmetic (Ginn)
171	Congruence of Numbers (Payne)
180	Introducing Exponents (SMSG EC)
181	Scientific Notation (SMSG)
182	Scientific Notation (Payne)
183	Powers and Scientific Notation (Md.)
184	Powers and Scientific Notation II (Md.)
190	Interesting Problems (Boys Own Arith)
191	Exploring Mathematical Ideas (Ginn)
192	Enlarging Mathematical Ideas (Ginn)
193	Extending Mathematical Ideas (Ginn)
194	Developing Mathematical Understanding, Book One (Holt)
195	Developing Mathematical Understanding, Book Two (Holt)
196	Developing Mathematical Understanding, Book Three (Holt)
197	Modern Mathematics (Singer)

Algebra

201	Symobls (Md.)
202	Translating English Sentences into Number Sentences (Md.)
203	Solving Story Problems Using Rational Numbers (BS)
204	Graphs on a Plane (Md.)
205	Introduction to Mathematical Sentences (Ginn)
206	Equations (SMSG)
207	Number Line and Coordinates (SMSG)
208	Real Numbers (SMSG)
209	Mathematical Systems (SMSG)
210	Finite Differences (SMSG Supp)
211	Variation (SMSG)
212	Graph Fun

UNITS IN LARGE CABINET (Continued)

Geometry

301	Introduction to Geometry (BS)
302	Non-metric Geometry
303	Plane Figures I (Md.)
304	Plane Figures II (Md.)
305	Constructions in Geometry (BS)
306	Mathematics and Perspective (Harcourt)
307	Sets in Geometry (Ginn)
308	Sets of Points (SMSG EA)
309	Recognition of Common Figures (SMSG EA)
310	Side and Angle Relationships of Triangles (SMSG EB)
311	Non-metric Geometry (SMSG)
312	Congruence and the Pythagorian Theorem (SMSG)
313	Basic Constructions with Compass and Straight Edge (F)
314	Bisecting an Angle (F)
315	Polygons of Equal Area (F)
316	Symmetry, Congruence, Pythagorean Property (SMSG)
317	Non-Metric Solid Geometry (SMSG)
318	The Sphere (SMSG)
319	Similar Triangles and Variation (SMSG)
320	Parallels, Parallelograms (SMSG)
321	Circles (SMSG)
322	An Idea in Solid Geometry (S)
323	The Nine-Point Circle (S)
324	Open and Closed Paths (SMSG Supp)
325	Projective Geometry (SMSG)
326	Construction of Triangles
327	Ployhedra

Logic

401	Understanding and Using Sets (Ginn)
402	Logical Reasoning (BS)
403	Logic and Number Sentences (Md.)
404	Logic and Language (SMSG)
405	Concept of Sets (SMSG EA)

Measurement

501	Topic Involving Measurement
502	Measurement (BS)
503	Systems of Measures (Md.)
504	Standardizing your Pace (Gaa)

UNITS IN LARGE CABINET (Continued)

Measurement

505	Hypsometer and Clinometer (Gaa)
506	The Compass (Gaa)
508	Astrolabe (Gaa)
509	Transit (Gaa)
510	Alidade—Transit (Gaa)
511	Jacobs Staff (Gaa)
512	Attempting to Estimate the Number of Stars in the Sky (Gaa)
513	Estimating (Md.)
514	Surface Areas and Volumes of Geometric Solids (F)
515	Applications of Rational Numbers (BS)
516	Linear Measure (SMSG EA)
517	Measurement of Angles (SMSG EB)
518	Area (SMSG EB)
519	Measurement (SMSG)
520	Problems (Gaa)
521	Approximate Numbers (Payne)
522	Measuring Irregular Areas (F)
523	Volumes and Surface Areas (SMSG)
524	Relative Error
526	Area, Volume, Weight, and Time
527	Introduction to Measurement

Statistics and Probability

601	Statistics-World's Best Cheaters
602	Averages (Md.)
603	Probability (BS)
604	Arithmetic Mean (Payne)
605	Relatives and Strangers (F)
606	Pi and Probability (F)
607	Permutations and Selections (SMSG)
608	Probability (SMSG)
609	Statistics and Graphs (SMSG)
610	Heads or Tails?
611	Probability
612	Probability
613	Probability
615	Probability
616	Probability
618	Dependent Events
619	What are the Chances

UNITS IN LARGE CABINET (Concluded)

Computers and Computation

701	A Slide Rule Unit
702	Slide Rule Computation
703	Napier's Bones (S)

Problems and Problem Solving

801	Problem Solving (BS)
802	What Nobody Knows about Mathematics (SMSG)
803	Fun with Numbers (KPK)
804	Math Patterns in Science
805	What is Mathematics (SMSG)
806	Map-Coloring Problems (F)
807	How Time Doesn't Fly (F)
808	Mathematics and Science (SMSG)
809	Tower of Hanoi (S)
810	NIM (S)
811	Spider and Fly (F)
815-823	Are you a Private Eye?
824	Logic Problems
825	Game of Black
826	Magic Squares
827	Fox and Goose

Space and Space Travel

901	Data on First Four Earth Satelites
902	A Fourth Dimension Cube

PAMPHLETS

P1 Algorthm and Automatic Computing Machines (Heath) (2)
P2 Areas, Computation of Oriented Figures (Heath) (2)
P3 Codes, Secret, Remainder Arithmetic, and Matrices (NCTM) (3)
P4 Compute, Learninb to, No. 1 (World) (8)
P5 Compute, Learning to, No. 2 (World) (8)
P6 Computers, Digital and Related Mathematics (Ginn) (2)
P7 Computing Devices (Webster) (6)
P8 Computing, Short Cuts in (Webster) (6)
P9 Configuration Theorems (Heath) (2)
P10 Curves in Space (Webster) (4)
P11 Coordinate Geometry, Introduction to (Programed) (Holt) (4)
P12 Directed Numbers (Programed) (Holt) (5)
P14 Equation and Inequality, Concepts of (C.E.E.B.) (2)
P15 Equations and Inequalities (Programed) (Holt) (5)
P17 Fibonacci Numbers (Heath) (2)
P18 Figures, Equivalent and Equidecomposable (Heath) (2)
P19 Finite Mathematical Systems (Webster) (7)
P20 Function, Concept of a (Heath) (2)
P21 Geometry, Solid, Brief Units in (Holt) (2)
P22 Geometric Constructions (Webster) (5)
P23 Geometries, Famours (Tufts) (1)
P24 Graphs, How to Construct (Heath) (2)
P25 Graphing, Adventures in (Webster) (4)
P26 Graphing Relations and Functions (Heath) (2)
P27 Geometry Growing (NCTM) (3)
P28 Hyperbolic Functions (Heath) (2)
P30 Induction in Geometry (Heath) (2)
P31 Infinitely Small Quantities, Summation of (Heath) (2)
P33 Logarithms, Areas and (Heath) (2)
P34 Logic and Reasoning in Mathematics (Webster) (6)
P35 Logic, Elementary (Holt) (2)
P36 Mathematical Induction, Method of (Heath) (2)
P37 Mathematics, Fun with (Webster) (6)
P38 Mathematics, Invitation to (Webster) (6)
P40 Measurement, the World of (Webster) (6)
P41 Number Principles and Patterns (Ginn) (1)
P42 Natural Numbers (Heath) (2)
P43 Number Patterns (Webster) (7)
P44 Numbers and Numerals (NCTM) (4)
P45 (Numerals) The Story of Figures (Burroughs) (3)
P46 Numeration Systems, Understanding (Webster) (7)
P47 Number Stories of Long Ago (NCTM) (3)

PAMPHLETS (Concluded)

P48 Percents (World (1)
P49 Polyhedra, Regular; Infinity; Groups (Ginn) (2)
P50 Probability (NCTM) (1)
P51 Probability and Chance (Webster) (5)
P52 Projects, Handbooks, Mathematics (Heath) (2)
P53 Proof in Geometry (Heath) (2)
P54 Proof, Mistakes in Geometric (Heath) (2)
P55 Pythagorean Numbers, Congruences, Coordinates (Ginn) (2)
P56 Pythagorean Theorem (Webster) (7)
P57 Precision; A Measure of Progress (G.M.) (1)
P58 Random Numbers, Mathematical Induction, Geometric Numbers (Ginn) (1)
P59 Recreational Mathematics (NCTM) (1)
P60 Sets, Introduction to (Programed) (Holt) (5)
P61 Sets, Sentences and Operations (Webster) (5)
P62 Sets and the Structure of Algebra (Ginn) (5)
P63 Slide Rule, Introducing the (Lab. Specialties) (2)
P64 Statistics (World) (2)
P65 Statistics, The World of (Webster) (4)
P67 Theory of Games, Introduction to (Heath) (2)
P68 Topology (Webster) (5)
P69 Trigonometric Novelties (Tufts) (1)
P71 Vectors, Basic Concepts of (Webster) (5)
P72 Vectors in Three Dimensional Geometry (NCTM) (3)
P75 Paper Folding for the Mathematics Class (NCTM) (3)
P76 Number Theory, Some Ideas about (NCTM) (3)
P77 The Number Story (NCTM)(3)
P78 How to Study Mathematics (NCTM) (3)
P79 A Portrait of 2 (NCTM) (3)
P80 5 Little Stories (NCTM) (3)

BOOKS ON SHELVES

B41	Mathematics Enrichment A, (H.B.W.) (5)
B48	Mathematics for Elementary School and SMSG (1)
B58	Mathematics for Elementary School: 5 and SMSG (1)
B61	Seeing Through Arithmetic: 6 (Scott Foresma) (2)
B68	Mathematics for Elementary School: 6 and SMSG (1)
B71	Using Mathematics; (McGraw, Hill) (6)
P72	Growth in Arithmetic: 7 (Harcourt) (8)
B73	Foundations of Mathematics (H.R.W.) (1)
B74	Arithmetic At Work (Heath) (1)
B75	Exploring Modern Mathematics, Book I (Holt) (1)
B75P	Exploring Modern Mathematics—Programed (Holt) (11)
B76	Arithmetic—Concepts and Skills (Addison Wesley) (1)
B77	Contemporary Progress in Mathematics, Part I (Boston College)(5)
B78	Mathematics for Junior High School, Vol. I, Part I (SMSG) (3)
B79	Mathematics for Junior High School, Vol. I, Part II (SMSG) (5)
B82	Growth in Arithmetic: 8 (H.B.W.) (8)
B83	Modern Mathematics, Book II, (Silver Burdett) (2)
B84	Arithmetic In Life (Heath) (1)
B85	Exploring Modern Mathematics, Book II (H.R.W.) (1)
B86	Introduction to Mathematics (Addison Wesley) (1)
B87	Contemporary Progress in Mathematics, Part II (Boston College) (5)
B88	Mathematics for Junior High School, Vol. 2, Part I (SMSG) (3)
B89	Mathematics for Junior High School, Vol. 2, Part II (SMSG) (4)
B90	SMSG Algebra
B91	Functional Mathematics, Book I (Scribners) (1)
B92	Contemporary Algebra, Book I (H.B.W.) (1)
B93	Arithmetic Sentences (Washington University) (5)
B94	Contemporary Algebra, Book I (H.R.W.) (3)
B95	Contemporary Algebra, Book II (H.R.W.) (3)
B96	Contemporary Algebra, Book III (H.R.W.) (3)
B97	Contemporary Algebra, Book IV (H.R.W.) (2)
B98	Contemporary Algebra, Book V (H.R.W.) (2)
B99	Basic Ideas of Mathematics (Harcourt) (2)
B100	Accelerated Algebra
B101	Functional Mathematics, Book II (Scribners) (1)
B102	Geometry Plane and Solid (Laidlow) (1)
B103	Geometry (Heath) (1)
B104	Fun with Figures (Random House)
B105	Trouble Shooting Math Skills (Holt)
B111	Mathematics for the Consumer (World Book) (3)
B112	Contemporary Algebra, Book II (HBW)
B121	Introduction to Probability (McGraw, Hill) (3)

BOOKS ON SHELVES (Continued)

B122	Plane and Spherical Trigonometry (American) (1)
B201	Numbers—Rational & Irrational (New Mathematical Library) (2)
B202	What is Calculus About? (N.M.L.) (2)
B203	Introduction to Inequalities (N.M.L.) (2)
B204	Geometric Inequalities (N.M.L.) (2)
B205	Contest Problem Book (N.M.L.) (3)
B206	Lore of Large Numbers (N.M.L.) (3)
B207	Uses of Infinity (N.M.L.) (1)
B209	Continued Fractions (N.M.L.) (5)
B210	Graphs & Their Uses (N.M.L.) (4)
B211	Slide Rule (Doubleday) (1)
B212	Practical Mathematics (Doubleday) (1)
B213	Introduction to Electronics (Doubleday) (1)
B214	Trigonometry—A Practical Course (Doubleday) (1)
B215	Adventures in Algebra (Doubleday) (1)
B216	Arithmetic of Computers (Doubleday) (1)
B217	NCTM 27th Yearbook Enrichment
B218	NCTM 28th Yearbook Enrichment
B250	Temac Basic Mathematics (Temac) (1)
B251	Temac Whole Numbers & Numerals (Temac) (1)
B252	Temac The Arithmetic of Whole Numbers (Temac) (1)
B253	Temac Seventh Grade Mathematics (Temac) (1)
B254	Temac Modern Mathematics (Temac) (1)
B255	Temac Verbal Problems in Algebra (Temac) (1)
B256	Temac Introductory Descriptive Statistics (Temac) (1)
B303	Bell, *Men of Mathematics*
B304	Berkley, *Probability and Statistics* (1)
B306	Beutly & Potts, *Geometry I* (3)
B309	Boehm, *The New World of Math*
B312	Bowers & Bowers, *Arithmetical Excursions*
B315	Buchlein, *Space Handbook*
B318	Coleman, *Relativity & The Layman*
B321	Coolidge, *The Mathematics of Great Amateurs*
B324	Court, *Mathematics in Fun & Earnest*
B325	Cutler and McShane, *The Trachtenberg Speed System of Basic Mathematics*
B326	Engel, *How to Buy Stocks*
B327	Englehardt, *Computers*
B328	Eves, An Introduction to the History of Mathematics
B330	Gamow, *One, Two, Three, Infinity*
B333	Gardner, *Logic, Machines & Diagrams*
B336	Hooper, *Makers of Mathematics*
B339	Logsdon, *A Mathematician Explains*
B340	27th Yearbook (NCTM) (4)
B341	28th Yearbook (NCTM) (2)

BOOKS ON SHELVES (Concluded)

B342	Newman, *Men & Numbers*
B343	Newman, *The World of Laws & The World of Chance*
B344	Newman, *The Mathematical Way of Thinking*
B345	Newman, *Machines, Music, & Puzzles*
B348	Sawyer, *A Concrete Approach to Abstract Algebra*
B349	Sawyer, *Mathematician's Delight*
B350	Sawyer, *Prelude to Mathematics*
B353	Schaff, *Mathematics for Everyday Use*
B356	Stibits, *Mathematics & Computers*
B359	Titchmarsh, *Mathematics for the General Reader*
B362	Turnbull, *The Great Mathematicians*
B365	Upton, *Electronics for Everyone*
B368	Vergara, *Mathematics in Everyday Things*
B371	Young, *Monographs—Modern Mathematics*

MATERIALS FILED IN FOLDERS

For Classroom File

1005	ABACUS
1010	BINOMIAL EXPANSION, THEOREM
1012	BIOLOGY
1015	CALCULATING MACHINES
1020	CHECKING ANSWERS
1025	CHEMISTRY EXPERIMENTS
1030	COMBINATIONS & PERMUTATIONS
1035	CONIC SECTIONS
1037	CURVE STITCHING - PAPER FOLDING
1040	ELECTRONIC COMPUTERS
1042	ELECTRONICS
1045	EQUATIONS & NUMBER SENTENCES
1048	IDEAS TO EXPLORE
1050	LARGE NUMBERS
1055	LATITUDE & LONGITUDE
1060	LIMITS & DERIVATIVES
1062	MAGIC SQUARES
1064	MATHEMATICS COMPETITIONS
1066	MATHEMATICS IN INDUSTRY
1068	MATHEMATICS STUDENT JOURNAL
1070	MEASUREMENT OF ANGLES
1072	MEASUREMENT OF LENGTH, AREA, VOLUME
1074	MEASUREMENT OF TIME
1076	MEASURING VELOCITY
1078	MISCELLANEOUS PUZZLES
1080	MONEY
1082	MULTIPLICATION
1085	NUMBER ODDITIES
1090	NUMBER SYSTEM, PROPERTIES
1095	NUMERATION SYSTEMS
1098	PHYSICS
1100	POLYHEDRONS
1105	PRIMES
1110	PROBABILITY
1112	SCIENCE
1115	SLIDE RULES
1120	SPACE TRAVEL
1125	STOCKS, BONDS, INVESTMENT, TAXES
1130	SYMBOLS
1140	ZERO

APPENDIX II. DAILY OBSERVED BEHAVIOR RECORD

Class ____________________ Date ____________________

	A B C	A B C	A B C	A B C	A B C
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
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18.					
19.					
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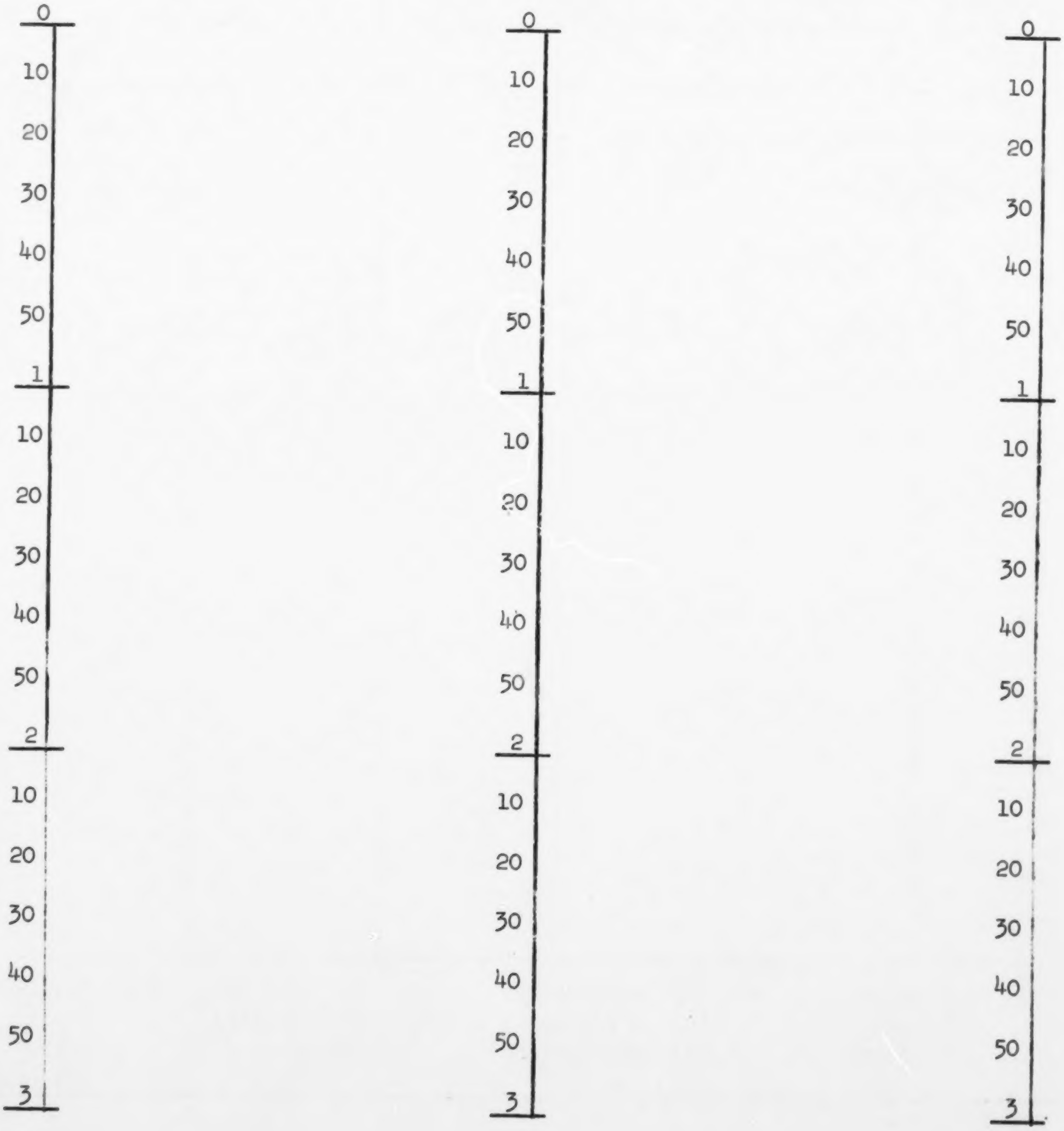
21.					
22.					
23.					
24.					
25.					
26.					
27.					

A.	(1)	alone	B.	(1)	industrious	C.	(1)	passive	(T)	inter-acting with teacher
	(2)	pair		(2)	coasting		(2)	writing		
	(3)	group		(3)	not working		(3)	active		

Special Notes:

APPENDIX III. 3-MINUTE TEACHER BEHAVIOR SAMPLE


0
10
20
30
40
50
1
10
20
30
40
50
2
10
20
30
40
50
3
0
10
20
30
40
50
1
10
20
30
40
50
2
10
20
30
40
50
3
0
10
20
30
40
50
1
10
20
30
40
50
2
10
20
30
40
50
3

APPENDIX IV. STUDENT MATERIAL-USE RECORD

Name	Date/Item											
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												
11.												
12.												
13.												

APPENDIX V. EVALUATION FORMS

JUNIOR HIGH MATHEMATICS — GRADE 7

NAME ____________________

DATE ____________________

At the beginning of the year, we took two standardized mathematics achievement tests. This shows where I stand in my group.		During the quarter I have spent this percentage of my class-time industriously.
SNADER TEST	CALIFORNIA TEST	PERCENT
Number Correct	Grade Equivalent	
43 (1)	10.8 (1)	83 (1)
38 (1)	9.7 (1)	80 (1)
36 (1)	9.2 (1)	76 (1)
30 (1)	9.0 (1)	72 (1)
28 (1)	8.9 (1)	71 (2)
27 (3)	8.8 (1)	70 (1)
26 (2)	8.5 (2)	67 (1)
25 (2)	8.4 (1)	66 (1)
24 (4)	8.2 (1)	65 (2)
23 (2)	8.1 (2)	63 (2)
22 (1)	8.0 (2)	61 (2)
21 (4)	7.9 (5)	59 (1)
20 (3)	7.8 (3)	58 (2)
19 (1)	7.7 (2)	57 (3)
17 (4)	7.6 (2)	55 (2)
16 (5)	7.5 (1)	54 (3)
15 (1)	7.4 (1)	52 (2)
14 (4)	7.3 (1)	51 (3)
13 (1)	7.2 (1)	50 (2)
12 (1)	7.1 (3)	49 (1)
11 (1)	6.9 (4)	48 (2)
10 (1)	6.8 (1)	47 (2)
9 (1)	6.7 (1)	46 (2)
7 (1)	6.5 (1)	45 (2)
5 (1)	6.4 (1)	44 (2)
4 (1)	6.2 (2)	42 (1)
2 (1)	6.1 (1)	40 (1)
	6.0 (1)	37 (2)
	5.6 (1)	34 (1)
	5.3 (1)	32 (1)
	4.3 (1)	28 (1)

The Quantity of my work this quarter was rated by my teacher as:

especially adequate

adequate

somewhat inadequate

completely inadequate

The Quality of my work this quarter was rated by my teacher as:

especially good

generally good

rather poor

very poor

On the basis of all of these factors, my teacher and I have decided my grade should be: ______

NAME ______________________

7th Grade Summary

Industry Ratio 2nd Semester	Estimated Number of 10-Page Units Completed During Year	Standing on Final Achievement Test, Raw Score	
		SNADER TEST	STEP TEST
91 (1)	50 (2)	34 (2)	46 (1)
88 (1)	49 (1)	33 (1)	41 (1)
84 (1)	43 (1)	30 (1)	40 (3)
83 (5)	38 (1)	29 (2)	39 (2)
82 (3)	36 (1)	27 (4)	38 (1)
80 (1)	35 (1)	25 (1)	37 (5)
78 (4)	33 (1)	24 (2)	36 (2)
76 (2)	30 (3)	23 (6)	35 (1)
75 (2)	29 (1)	22 (3)	34 (2)
74 (1)	25 (1)	21 (4)	32 (4)
73 (1)	24 (1)	20 (2)	31 (3)
72 (1)	23 (1)	19 (1)	30 (3)
71 (1)	22 (1)	18 (1)	29 (2)
70 (1)	21 (1)	17 (6)	28 (1)
69 (5)	20 (1)	16 (2)	27 (1)
68 (1)	19 (2)	15 (2)	26 (2)
68 (1)	18 (3)	14 (1)	23 (3)
66 (1)	16 (5)	13 (3)	22 (1)
65 (2)	15 (1)	11 (1)	21 (1)
63 (2)	14 (1)	9 (1)	20 (2)
62 (1)	13 (2)	8 (1)	18 (1)
61 (2)	12 (2)		16 (1)
59 (1)	11 (1)		15 (2)
58 (1)	10 (1)		11 (1)
57 (2)	8 (4)		
51 (2)	7 (2)		
50 (2)	6 (2)		
32 (1)	4 (2)		
	3 (4)		

APPENDIX VI. MATERIALS IN THE FIFTH GRADE CLASSROOM

MATH MATERIALS

BOOKS

TEXTBOOK SERIES (CONVENTIONAL):

- *Arithmetic At Work* - Book 1
- *Arithmetic We Need* - Book 6
- *Growth in Arithmetic* - Books 3, 4, 5, 6, 7, and 8
- *Making Sure of Arithmetic* - Books 3, 4, 5, 6, and 7
- *Seeing Through Arithmetic* - Books 3, 4, 5, and 6
- *The New Thinking With Numbers* - Book 7
- *The New Understanding Numbers* - Book 6

OTHER SERIES (NEW):

- School Mathematics Study Group:
  - Grade 4 - Parts I, II
  - Grade 5 - Parts I, II
  - Grade 6 - Parts I, II

- Ginn Arithmetic Enrichment Program:
  - *Exploring Mathematical Ideas*
  - *Enlarging Mathematical Ideas*
  - *Extending Mathematical Ideas*

- Holt, Rinehart and Winston:
  - *Developing Mathematical Understanding* - Books 1, 2, and 3

- Learning Materials, Inc.:
  - Math Lab Materials - *The Blue Book*
    - *The Orange Book*
    - *The Red Book*
    - *The Yellow Book*

PROGRAMMED TEXTS:

- Macmillan Programmed Texts:
  - *What Are The Chances? An Introduction to Probability*
  - *Points, Lines, and Planes: An Introduction to Geometry in Two Dimensions*
  - *Number Sentences: An Introduction to Equation Solving*

PROGRAMED TEXTS:

Factors and Primes: An Introduction to Number Theory
Bases and Numerals: An Introduction to Numeration

Holt, Rinehart and Winston Programmed Texts:
A Program in Contemporary Algebra-
- Book 1 - *Sets, Numbers, and Language of Algebra*
- Book 2 - *Equations and Inequalities in One Variable*
- Book 3 - *Equations and Inequalities in Two Variables*
- Book 4 - *Polynomial Expressions, Relations, and Functions*
- Supplement - *Exploring Modern Mathematics* - Book 1

PAMPHLETS BY ROW, PETERSON AND CO.:

"Arithmetic in Action"
"Arithmetic of Long Ago"
"Amusing Problems"
"Calendar Fun"
"Check and Double Check"
"Counting by Countries"
"Crossnumber Puzzles" - for grades 3, 4, 5, 6, 7, and 8
"Excursions in Arithmetic"
"Faster and Faster"
"Find the Number"
"Fun with Words"
"Games to Play"
"Guzintas"
"Just Like Magic"
"Jokes and Riddles"
"Magic Squares"
"Magic Squares, Circles, Stars"
"Mathematics in Action"
"Nimble Numbers"
"Numbers Do Strange Things"
"Number Games"
"Number Magic"
"Number Stories"
"Number Systems"
"Oddities of Numbers"
"Probability and Statistics"
"Queries and Queeries"
"Short Cuts to Multiplying"
"Side Trips in Arithmetic"
"Some Curious Numbers"
"The Story of Counting"
"The Story of Measures"
"The Story of Money"

PAMPHLETS BY ROW, PETERSON AND CO.:
"The Story of Time"
"The Story of Zero"
"Ways to Multiply"

TEACHER-MADE WORK SHEETS

TOPICS:

- Addition
- Subtraction
- Multiplication - by 3's and 4's
- Division
- Fractions
- Mod Arithmetic - Time, Calendar, Clock
- Combination Arithmetic
- Mathematical Games
- Mathematical Riddles
- Averages
- Number Lines
- Number Theory
- Powers and Roots
- Sets
- Graphs
- Linear Measures - Length, Height, Width, Perimeter
- Measurement Conversion
- Geometry - Solids, Surfaces, Lines, Angles

GAMES:

- Quizmo Game
- Easy Money
- The 15 Puzzle
- Thirteen
- Big Business
- I Win
- Dizzy Decimals
- Hexstat (Probability Game)

GADGETS:

- Addition Flashcards
- Subtraction Flashcards
- Multiplication Flashcards
- Prentice-Hall Manipulative Materials (Pertaining to Fractions)

GADGETS:

- Abaci
- Number Wheel
- Large Model of a Protractor
- Templates - Triangle, Square, Diamond
- Measuring Devices
- Hundred Board

RECORDS:

"Musical Multiplication Tables"